University of Alberta

The Cost Competitiveness of Alberta Dairy Farms

by

Heather-Anne Ruth Grant ©

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfilment of the requirements for the degree of Master of science

in

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This thesis is dedicated to my family
whose support has helped me to persevere.

To my Mom, Mary Anne, who taught me the importance of being an educated woman. Who taught me the power of positive thinking and that anything is possible if you believe in yourself. Who taught me to have faith in God above all else- "the Lord provides!"

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One cannot discover new oceans unless she has
the courage to lose sight of the shore.

ABSTRACT

The World Trade Organization (WTO) is currently formulating an agenda for a new round of global trade negotiations; therefore, the likelihood of increased competition within Canada's supply managed dairy industry is probable. Consequently, there is a greater need for producers to be concerned with their competitiveness in the international marketplace. This study assesses the cost competitiveness of Alberta dairy producers by estimating the economic costs associated with milk production, deriving the physical and economic efficiency of producers, and imputing the economic profit of farms under international price scenarios. Results support the presence of economies of size and economies of yield within Alberta milk production. A link between increased herd size, labour productivity, and lower total labour costs was identified. The results also indicate that by decreasing both feed costs and family labour expenses, producers can improve their economic profit at the international level.

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CHAPTER 1: INTRODUCTION

1.1 PROBLEM SETTING

Marketing and pricing of milk for Canada's dairy industry is governed by a system of supply management. This method of orderly marketing dates from the 1940's, but was formally introduced at the national level in the early 1970's as an attempt by the federal government to combat mounting stocks of dairy products and potential falls in prices. Since its inception, an intense dispute over the effectiveness of supply management as a policy approach has occurred in Canada. However, while a debate of market failure versus rent seeking has occurred domestically, future pressures on Canada's dairy industry can be expected to arise from the globalization of agricultural markets.

One fundamental component of Canada's existing supply management system has been its reliance on import controls for foreign dairy products. Complying with the General Agreement on Tariffs and Trade (GATT) rulings on agriculture, formulated in the Uruguay Round, Canada's dairy sector was obligated to convert previous import quotas to tariff equivalents in the mid-1990's. Canada committed to making specified reductions in these tariffs during the implementation. A pressing challenge for the industry lies in the fact that the current system of supply management, which is based on domestic and import control, would be untenable in an open market.

Jeffrey (1992) summarizes the concerns of many producers rooted in the idea of a Canadian dairy sector with a substantial reduction or a complete elimination of import controls:

> It is reasoned that either or both of these changes will result in less stable and lower farm-level milk prices, as well as increased competition from US producers. The US dairy sector is much larger than the Canadian sector and it is perceived that US producers enjoy a comparative advantage in milk production. Once domestic policies are removed, Canadian producers might not be able to effectively compete and many of these producers will therefore be forced out of business (p.1).

Over the past three decades, the structure of the Alberta dairy sector has changed substantially. Specifically, the total number of dairy farms in the province has decreased, while at the same time, herd sizes and average production levels per cow have increased. According to Statistics Canada (1996), between 1981 and 1996 the total number of dairy operations in Alberta fell 68 percent from 8,827 to 2,822. Ross et al (1998) state that provincial milk production per farm increased twelvefold from 16,952 litres in 1961 to

210,698 litres in 1996. Kotowich et al (1998) report the average Alberta dairy farm milked 83 cows in 1998. Alterations to Canada's supply management system, in the form of reduced tariffs on dairy imports, may reinforce these trends.

1.2 PROBLEM STATEMENT

With the World Trade Organization (WTO) currently formulating an agenda for a new round of global trade negotiations, the likelihood of increased competition in the Canadian dairy industry is probable. Changes in Canada's supply management system would undoubtedly have implications at the farm level. Consequently, there may be a greater need for producers to be concerned with their *competitiveness*. However, there is a lack of information in this area. How competitive are Alberta dairy producers? What management factors contribute to increased competitiveness, however that is defined?

There is a general belief that economies of size exist in dairy production, although the extent to which these are realized is likely affected by domestic dairy policy. If size is defined as total milk production, economies of size can be viewed as having two parts; herd size economies and milk yield economies. Increased "size" may be one means by which Alberta dairy producers may maintain or improve their competitiveness. However, to what degree do these economies exist in Alberta dairy production, and how important are they in relative terms? These questions provide the focus for the analysis to be conducted in this thesis study.

1.3 OBJECTIVE

The objective of this research is to assess the cost competitiveness of Alberta dairy producers. Specifically, this study investigates the nature of dairy costs of production in Alberta. It is hypothesized that economies of herd size and economies of milk yield exist in Alberta milk production. Management factors contributing to these economies are examined. In order to assess the competitiveness of Alberta dairy producers in a global marketplace, profitability figures are computed under alternative international milk price scenarios. Finally, the level of physical and economic efficiency of Alberta dairy producers will be evaluated.

1.4 THESIS OUTLINE

Chapter 2 of this thesis provides a brief description of Alberta's dairy sector and a review of dairy policy in Canada and Alberta. Chapter 3 presents a critical analysis of the concept of farm competitiveness. Chapter 4 contains a review of pertinent literature relating to the competitiveness of dairy producers in an open marketplace. Chapter 5 describes the data utilized and the methodology adopted by this thesis. The results of the analysis are presented and discussed in Chapter 6. Chapter 7 outlines the conclusions and limitations of this thesis and gives suggestions for further research.

CHAPTER 2: BACKGROUND

2.1 THE ALBERTA DAIRY INDUSTRY

In terms of relative economic contribution, Alberta's dairy industry is regarded as the province's third largest agricultural sector, behind red meats and grains. Approximately $325 million in dairy farm gate receipts is generated annually in Alberta and $700 million in total value-added dairy products is produced each year in the province (Alberta Milk Producers).

The 1996 Statistics Canada Census of Agriculture reported that 9.1 percent of Canada's 30, 926 dairy farms were located in Alberta in that year. During the period between 1981 and 1996, the total number of dairy operations in the province declined 68 percent from 8,827 to 2,822. According to Ross et al (1998), historically, most of Alberta's dairy producers were cream shippers. These authors note that from 1974 to 1996, dairy farms registered exclusively as cream producers decreased from 10,620 to 44. The same trend is observed with respect to the province's industrial milk suppliers. Ross et al (1998) report that producers shipping exclusively industrial milk decreased from 1,218 in 1974 to 0 in 1994. Ross et al (1998) contend that the decline of these two classes of dairy shippers is a result of the Graduated Entry Program carried out by the Alberta Dairy Control Board (ADCB) in 1975. They explain that the introduction of this policy encouraged producers to improve their dairy facilities, thereby improving the quality of their milk and permitting access to the more profitable fluid milk market. Ross et al (1998) report that by 1993 the quality of industrial and fluid milk was equivalent. Thus, the number of fluid milk producers increased and today, milk produced in excess of producer fluid milk quotas is sold to the industrial milk market.

Although the total number of dairy farms in Alberta has been declining steadily, total milk production per farm and average milk production per cow have increased considerably. Ross et al (1998) note that the province's average total milk production per farm increased twelvefold from 16,952 litres in 1961 to 210,698 litres in 1996. The Alberta Dairy Control Board (1998) reports that total milk production in Alberta during the 1997/1998 dairy year exceeded 608 million litres, making Alberta the third largest milk producing province in Canada, behind only Quebec and Ontario. Cameron and Gould (1998) report that despite the province's total number of milk cows having decreased from 250,000 in 1965 to less than 100,000 today, provincial milk production has increased. According to Ross et al (1998), annual milk production per cow in Alberta averaged 5,773 litres in 1996, behind only British Columbia, Ontario and Quebec which in 1996 realized averages of 6,909 litres per cow, 5,905 litres per cow and 5,783 litres per cow, respectively.

According to Kotowich et al (1998), Alberta dairy farms milked, on average, 83 head of cattle in 1998. As in other regions of Canada, the Holstein is the most popular dairy cow breed in Alberta. Cameron and Gould (1998) state that 97.6 percent of the province's dairy cattle are Holsteins, 1.2 percent are Jerseys while the remainder consist of Ayrshire, Brown Swiss and Guernsey breeds.

The typical Alberta dairy farm consists of a double 6 milking parlor with a free-stall system of individually bedded stalls.[1] In recent years confined feeding of a total mixed ration has become the predominant method of feed management by the province's dairy producers.

Ross et al (1998) note that in 1995, 43 percent of Alberta's dairy farms were located between the cities of Edmonton and Red Deer in the province's west central region. According to Ross et al (1998), 33.6 percent of Alberta dairy farms operating in 1995 were situated south of Calgary. This is an increase of 55.6 percent over the 21.24 percent of the province's dairy herd located in this region in 1971. During this same period, Ross et al (1998) report that the percentage of Alberta's dairy operations in the east central region and the north central/north east region decreased from 20.75 percent to 12.08 percent and from 17.26 percent to 9.24 percent, respectively.

2.2 CANADIAN DAIRY POLICY

As reported by Dolphin (1998), stakeholders in the Canadian dairy industry first attempted to employ a supply controlled milk system in the 1930's to alleviate price and supply instability following the First World War and the Great Depression. Implementation at this time failed due to the inability to ratify federal legislation pertaining to the proposal. In 1958, the Agricultural Stabilization Board was established and provided the framework necessary for the industry to achieve price stabilization through the exportation of surplus products, controls on imports, and support prices. However, the Agricultural Stabilization Board was unable to resolve two major problems affecting the country's dairy sector: (1) a lack of coordination between federal and provincial policies and (2) the absence of an effective mechanism to control milk production (Canadian Dairy Commission, 2000a). Unstable milk supplies and highly variable producer prices persisted and according to Veeman (1975), annual federal subsidies to dairy farmers topped $100 million in 1963- a new approach was required.

On October 31, 1966, based on recommendations from a national dairy advisory committee, the federal government instituted the *Canadian Dairy Commission Act*. The Canadian Dairy Commission (CDC) assumed the role of chief administrator for the national milk supply management system. Although federal jurisdiction over the supply management system essentially lies in the hands of the CDC, several other federal and provincial government departments are responsible for the operation of vital components. The two markets existing in Canada for raw milk, fluid and industrial, define the powers delegated to the various agencies.

2.2.1 The Fluid Milk Market

The fluid milk market consists of table milk and fresh cream. In 1998 this market accounted for 39 percent of total milk production in Canada or 30.9 million hectolitres of milk (Canadian Dairy Commission, 2000b). Each province has the authority to regulate the quality and price of fluid milk as well as the distribution of fluid milk production quota between farmers within its geographic boundaries.

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[1] Cameron, Brian. 1999. Personal Communication. Edmonton, Alberta.

Prior to implementation of the national milk supply management system, provinces already applied controls over fluid milk markets. According to Veeman (1987), the mid-1930's saw the introduction of provincial fluid milk boards to combat the economic disturbances of the time. Veeman (1987) points out that establishment of these marketing boards met with little jurisdictional conflict due to the fact that the perishable nature of fluid milk confined markets to local areas.

2.2.2 The Industrial Milk Market

Industrial milk is manufactured into dairy products such as butter, milk powders, cheese, yogurt and ice-cream. In 1998, industrial uses of milk accounted for 61 percent of Canadian milk production or 48.5 million hectolitres (Canadian Dairy Commission, 2000b). Industrial milk products are typically traded between or beyond provinces and are therefore regulated under the authority of the federal government. Specifically, the orderly marketing of industrial milk on a national level is executed by means of market sharing quota (MSQ), as outlined in the *National Milk Marketing Plan*.

The *National Milk Marketing Plan*, an agreement between the federal and provincial governments, is administered by the Canadian Milk Supply Management Committee (CMSMC). The CMSMC is chaired by a member of the CDC and consists of provincial government and producer representatives who meet on a bi-monthly basis. The committee excludes representation from Newfoundland because the province is not a signatory member of the *National Milk Marketing Plan* as it does not produce a significant volume of industrial milk. Instead, Newfoundland holds an observer status on the committee. Other non-voting observers of the CMSMC include domestic producer, processor and consumer organizations (Canadian Dairy Commission, 2000c).

2.2.3 Milk Pricing

Milk prices paid to producers differ between provinces. However, all are based on a system of 'classes' representative of specified end uses for the milk. The price received by producers for the various classes of milk is determined through Multiple Component Pricing (MCP). With MCP, milk is priced according to its components; butterfat, protein and other solids (lactose, minerals, vitamins). The value of each component in a given class is based on provincial price levels of milk within that class (Kotowich et al, 1998).

In every province, fluid milk commands a higher price than industrial milk used in the production of various dairy products. Ewing (1994) notes that the price of fluid milk is typically based on provincial cost of production studies, and that price differences between provinces are due to differences in costs of production or contrasting methods adopted to compute costs of production. Some provinces have regulated retail or wholesale pricing of fluid milk which leads to a minimum and/or maximum retail or wholesale price being assigned to fluid milk (Ewing, 1994). The prices for industrial milk classes tend to be more uniform across provinces due to the federal support program.

2.2.4 Special Milk Classes and Pooling System

Prior to 1995, Canada financed exportation of surplus milk by means of an over quota levy charged to producers. The Uruguay Round *Agreement on Agriculture* of the General Agreement on Tariffs and Trade deemed over quota levies to act as subsidies. Subsequently, the Canadian dairy industry introduced a fifth category of milk pricing, the 'Special Milk Classes' (or Class 5) and a milk revenue pooling system on August 1, 1995 (Dolphin, 1998).

The Class 5 grouping included dairy products used as value added ingredients in both domestic and foreign markets. According to the Alberta Dairy Control Board (1998), the marketing costs of removing structural surplus milk in the domestic Canadian market are incorporated into the Class 5 milk price. Revenue generated from the sale of Class 5 industrial milk is 'pooled' with higher priced classes of milk sold in the domestic market. This is reflected in the producer prices in the nine provinces that are signatories to the *National Milk Marketing Plan* or the P9 pooling arrangement (Canadian Dairy Commission, 2000d).

On September 5, 1997, the American government filed a petition against Canada's Special Milk Classes protesting that Special Classes 5(d) and 5(e) act as export subsidies. As described by Mussell and Martin (2000):

> The complainants identified the Special Milk Classes scheme as an implicit export subsidy because it uses revenue from higher valued domestic classes (Class 1-4) as a means to subsidize below-cost sales of milk to the export market (Class 5(d) and (e)) through class pooling. Because the higher priced domestic market is maintained through the regulatory actions of federal and provincial supply management agencies, the Americans . . . alleged that the implicit export subsidy was illegal (p.2).

In 1998, New Zealand joined the United States in this challenge through the WTO dispute settlement system (Alberta Milk Producers, 1999). A panel representing the WTO's *Dispute Settlement Understanding* ruled in favor of the filed complaint. Canada appealed this decision; however, in November 1999, the Appellate Body upheld the major features of the previous WTO ruling. The Appellate Body concluded that the parties involved in the decision making process of the CMSMC are government agencies, and because they administer the price pooling involving Special Classes 5(d) and 5(e), a direct export subsidy to producers was identified.

In response to the WTO ruling, the CDC implemented a contract system to export Canada's surplus of milk. Currently it is proposed that producers enter into a contract with their processors where a specific level of their over-quota milk production is to be sold in export markets. It is expected that Canada will only be able to sell this contracted milk on the world market. Milk produced in excess of a farm's contracted amount must be sold on the domestic market.

Independent of the P9, two other milk pooling agreements exist for domestic fluid and industrial milk. The first of the two pooling arrangements is referred to as the Eastern All Milk Pool or the P6. The P6, implemented on August 1, 1996, pools the returns of milk sales among dairy producers in Prince Edward Island, Nova Scotia, New Brunswick, Quebec, Ontario and Manitoba. The second milk pooling arrangement was established in March 1997 and is known as the Western Milk Pool or the P4. The P4 is comprised of Manitoba, Saskatchewan, Alberta and British Columbia. Manitoba, participating in both pools, shares revenue and markets in the Western Milk Pool, but shares only revenue with the Eastern All Milk Pool (Dolphin, 1998).

Under the P6 and P4 agreements, a maximum of 6 percent of each provinces' monthly milk production may be moved between provinces (Kotowich et al, 1998). An interprovincial quota exchange was operated by Nova Scotia, Quebec and Ontario for a short time. It collapsed when Ontario withdrew in early 1998 with Nova Scotia following later that same year. Each claimed they had lost more than 1 percent of their allotted MSQ to Quebec (Ontario Milk Producer, 2000). To date an interprovincial quota exchange has not operated in the P4, but whole farm transfers, including farm quota holding, are permitted between P4 provinces.

2.3 COMPONENTS OF CANADIAN SUPPLY MANAGEMENT

Richards (1993) reports the specific goals of Canadian dairy policy as being to maintain:

(1) self sufficiency in fluid milk supplies and in the supply of manufactured dairy products;
(2) year round continuity of supply of fluid milk and milk products;
(3) seasonal price stability;
(4) adequate or fair returns to efficient producers' resources; and
(5) interproducer equity in prices received for milk of given quality.

The industry pursues these goals through the operation of domestic marketing quotas, support prices for industrial milk products, import controls, and a federal milk subsidy. These four instruments are described below.

2.3.1 Domestic Marketing Quotas

Regulation of domestic milk production is directed at avoiding shortages or surpluses of milk. Producer marketing quotas for both industrial and fluid milk are employed to achieve a balance between the supply and demand of dairy products.

Provincial shares of MSQ are set each year by the CMSMC. The specific formula used to calculate MSQ is as follows:

MSQ = butterfat requirements in milk equivalent (based on average composition of milk) + 4% export sleeve - allowable imports (1)

Nonfat solids and butterfat requirements for the previous year are calculated by the CDC using a "stock reconciliation method" (Ewing, 1994). As explained by Dolphin (1998), this method takes into account domestic production levels, beginning and year end inventories for selected dairy products, export quantities and milk sales of the previous year. An "export sleeve" has acted as a buffer to ensure that no milk shortage will incur in the domestic market and to give a guaranteed quantity of dairy products for export business (Canadian Dairy Commission, 1997; Ewing, 1994). For the 1998/1999 dairy year, the CMSMC set the national MSQ at 44.6 million hectolitres, a 4 percent increase over the previous year. Growth in the demand for dairy products was the basis for this decision (Canadian Dairy Commission, 2000e).

Individual provinces divide their respective share of MSQ among dairy producers according to policies that vary by province (Canadian Dairy Commission, 1997). Quebec and Ontario receive the largest allocations of MSQ; 47.4 percent and 30.6 percent respectively, in the 1998/1999 dairy year. The next largest share is allocated to Alberta, which was allotted 6.2 percent of national MSQ for the 1998/1999 dairy year (Canadian Dairy Commission, 2000f).

Like MSQ, fluid milk quotas are set on an annual basis, but these are regulated by provincial agencies as opposed to the CMSMC. Ewing (1994) reports that provinces set fluid milk quota levels according to provincial demand. Any excess fluid milk production is allocated to the processing of industrial milk products (Ewing, 1994).

2.3.2 Support Prices

To achieve the objective of ensuring a fair return to efficient producers, a support price program for butter and skim milk powder was instituted as an element of Canada's supply managed dairy industry. The Canadian Dairy Commission (1997) describes a fair return as an amount sufficient to cover cash costs, labour and investment related to the production of milk sold for industrial purposes.

By formulating support prices for butter and skim milk powder, the CDC sets a minimum price for the two commodities. Because the CDC offers to purchase butter and skim milk powder from processors at the support prices, a floor price for each is established (Ewing, 1994).

In 1975, the CDC developed a Returns Adjustment Formula to calculate support prices for butter and skim milk powder. This was an attempt to incorporate a realistic approximation of producer costs into the support prices paid to farmers. In 1988 this formula was replaced by a farm level cost of production study (Canadian Dairy Commission, 2000a).

In 1991, the CDC established producer support prices for industrial milk. The federal government administers the industrial milk target price through two programs; a direct producer subsidy, and support prices set for butter and skim milk (Canadian Dairy Commission, 1996). The formula used by the CDC to calculate the target price for industrial milk is shown below:

Target Price = butter support price x butter yield + skim milk powder price x skim milk powder yield - assumed processor margin + direct subsidy **(2)**

According to Ewing (1994), the indicated butter and skim milk yields are measured in terms of kilograms per hectolitre of milk produced. Ewing (1994) defines the assumed processor margin as being representative of the non-milk costs in the joint production of butter and skim milk powder.

The target price is calculated at the beginning of each dairy year and reviewed every February. In December 1999, the CDC announced that as of February 1, 2000, the support price for skim milk powder and butter would increase from $4.5247 to $4.6842 per kilogram and $5.4667 to $5.5407 per kilogram, respectively. This decision was based on increased costs of production at the farm level (Canadian Dairy Commission, 2000g).

2.3.3 Import Controls

Import controls have been a basic feature of the operation of Canada's supply management system. The maintenance of support prices and the control of national milk supply would not be possible without the ability to restrict the amount of foreign dairy products entering the country (Dolphin, 1998).

Prior to 1995, Canada administered a variety of quantitative import restrictions on products consisting of at least 50 percent dairy content (Ewing, 1994). These included controls such as: fixed import quotas for cheese, ice cream, yogurt and buttermilk powder; discretionary licensing and import permits that were justified as being allowed under *Article XI* of the General Agreement of Tariffs and Trade (GATT) (Ewing, 1994).

In order to comply with the *Agreement on Agriculture* of the Uruguay Round negotiations, and the subsequent elimination of *Article XI*, signatories to GATT were required to convert existing non-tariff measures to bound tariffs, based on their specifications of the 1986-1988 tariff equivalent of the previous barriers. Average tariff levels were committed to be reduced by an unweighted average of 36 percent between the years 1995 and 2000. According to Schott (1994), countries were given much flexibility in exercising cuts for individual products as tariffs could be reduced for selected commodities by more than the unweighted average and less than the average for other products. However, it was required that each tariff be decreased by a minimum of 15 percent over the six years.[2]

In accord with its commitments to the World Trade Organization (WTO), Canada replaced its quantitative import restrictions with tariffs and tariff rate quotas on January 1 and August 1, 1995, albeit at very high levels. Table 2.1 shows the calculated base tariff equivalent for six dairy products and the reduced tariff rate predicted for the year 2000.

A second stipulation with respect to import liberalization under the *Agreement on Agriculture* was the implementation of minimum access import quotas. These can be described as tariff-rate quotas (TRQ) (Schott, 1994). A TRQ is a 'two-stage tariff' where the

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[2] For developing countries, combined tariff reductions were required to average 24 percent with a minimum decrease of 10 percent over a ten year period.

TABLE 2.1: Tariff Equivalents for Canadian Dairy Products

PRODUCT	BASE TARIFF	2000 TARIFF
Milk	283.8% minimum $40.6 /hl	241.3% minimum $34.5 /hl
Cheddar Cheese	289.0% minimum $4.15 /kg	245.6% minimum $3.53 /kg
Butter	351.4% minimum $4.71 /kg	298.7% minimum $4.00 /kg
Yogurt	279.5% minimum $0.55 /kg	237.5% minimum $0.47 /kg
Ice Cream	326.0% minimum $1.36 /kg	277.1% minimum $1.16 /kg
Skim Milk Powder	237.2% minimum $2.36 /kg	201.6% minimum $2.01 /kg

Source: Agriculture and Agri-Food Canada (1997).

quantity of a product entering below the stated quota is subject to a lower tariff rate while quantities entering above the established quota are assigned the higher tariffs indicated in Table 2.1.

A general principle from the Uruguay Round was that countries were obligated initially to import 3 percent of the domestic consumption of a specified product. By the year 2000 this quota level was to rise to 5 percent. Under *Article 5* of the GATT agreement countries may impose special volume or price safeguards, but the two may not be administered simultaneously. Such measures may only be applied on a temporary basis, up to one year on a given commodity. Safeguard measures may be triggered by sudden movements in prices or volume (Schott, 1994).

2.3.4 Federal Milk Subsidy

A direct producer subsidy based on the quantity of industrial milk and cream shipments has been paid to producers since the formation of the *Canadian Dairy Commission Act* in 1966. Financing of the subsidy is provided by Agriculture and Agri-Food Canada under the stipulations of the *Farm Income Protection Act* (Canadian Dairy Commission, 2000h). The Canadian Dairy Commission (1997) contends that this federal payment was implemented as a means to moderate the price of industrial milk products to the consumer by decreasing the returns from the marketplace required by dairy farmers.

As reported by Ewing (1994), during the period between 1975 and 1992 producers received $6.03 per hectolitre of industrial milk production.[3] In 1993, this federal subsidy was decreased to $5.43 per hectolitre of milk due to overall government deficit reduction efforts. It was reduced a second time in 1995 to $4.62 per hectolitre and again in 1996 to $3.80 (Canadian Dairy Commission, 2000h).

In 1996, it was decided that the entire federal subsidy would be phased out over a five-year period. Annual reductions of $0.76 per hectolitre of milk were to have begun on August 1, 1997. As reported by the Canadian Dairy Commission (1997), this reduction was delayed by six months at the request of producers and processors and commenced instead on February 1, 1998. Annual reductions of $0.76 per hectolitre of industrial milk will continue until February 2002 when the federal subsidy is to be eliminated. In 1998 federal subsidy payments to Canadian dairy producers totaled $141.23 million (Canadian Dairy Commission, 2000i).

2.4 ALBERTA'S DAIRY POLICY

Examining Canada's dairy supply management system from a provincial perspective, control is held by various government agencies who comply with the CMSMC, according to the *National Milk Marketing Plan*. As previously stated, the primary function of these provincial offices is to operate the pricing of fluid milk and execute producer quota allocation for fluid and industrial milk. In Alberta, the Alberta Dairy Control Board (ADCB), and the Alberta Energy and Utilities Board (AEUB) have authority over these activities.

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[3] The volume of milk is calculated based on an assumed butterfat content; specifically 3.6 kilograms of butterfat.

2.4.1 Pricing Fluid Milk

The producer price for fluid milk is set by the AEUB and administered by the ADCB. Like the federally determined target price for industrial milk, the AEUB uses a formula reflecting items that influence the cost of milk production. Richards (1993) indicates that the formula reflects a 30 percent weight on demand pressures (the province's industrial wage rate and milk consumption), with the remaining 70 percent reflecting input prices and capital return pressures. Table 2.2 provides the specific cost and consumer factors and their respective weights used in calculating Alberta's fluid milk price.

According to Alberta Agriculture (1999), indices used in this formula are based on the latest available data and usually lag behind the current month. The monthly indices are divided by the 1986 base and then multiplied by its weight. The sum of these values produces the composite index. A "computed" fluid milk price is generated by multiplying the composite index by the 1986 price. The price "suggested" by the formula changes in $0.98 intervals. As Alberta Agriculture (1999) states, change is triggered when the computed price deviates positively or negatively from the suggested price by $0.49 or more. The AEUB will alter the fluid milk price only when a trend (two to three months) is observed in the price suggested by the formula. The current producer price for fluid milk in Alberta is $62.83 per hectolitre.

2.4.2 Producer Quota

Transfers of Alberta's provincial fluid milk quota, and its allotment of MSQ are administered by the ADCB using three separate quota exchanges: fluid, unused MSQ and used MSQ.[4] The fluid quota exchange operates monthly, while MSQ is exchanged only on a monthly basis between September 22 and June 22. A dairy producer wishing to purchase quota must submit a bid to the board stipulating the volume she/he wants to buy and the maximum price she/he is willing to pay. MSQ is measured in kilograms of butterfat per year, while fluid milk quota is defined in litres per day at 3.6 kilograms of butterfat (Alberta Dairy Control Board, 1998). As of January 2001, Alberta is the only province in Canada that still operates a dual quota system.

Upon collecting the producers' bids, the ADCB derives a market clearing price for each exchange. According to the Alberta Dairy Control Board (1998), the clearing price is set at the price where the smallest difference exists between the accumulated volume offered

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[4] The fluid quota exchange issues federal fluid quota and provincial fluid quota, expressed as the number of litres of Class 1 milk that a producer is entitled to deliver per day. The unused MSQ quota exchange provides federal and provincial quota for producer shares in the Canadian industrial milk market in kilograms of butterfat per year. The used quota exchange sells industrial milk quota that has already been used by a producer for the current year (Alberta Dairy Control Board, 1998).

TABLE 2.2: Alberta Fluid Milk Price Formula Components

COMPONENT	WEIGHT
Alberta Dairy Feed ($/tonne)	14
Alberta Hay Price ($/tonne)	14
Western Canadian Farm Wage Index	12
Western Canadian Farm Input Index	20
Canada Consumer Price Index	10
Alberta Industrial Wage ($/week)	16
Alberta Milk Consumption (l/month)	14

Source: Alberta Agriculture (1999).

for sale and the accumulated volume bid to buy. To avoid price distortion from excessively large bids on MSQ, the bids to buy are adjusted to 5 percent of annual MSQ (Alberta Dairy Control Board, 1998). The producers whose submissions are equal to or higher than the market clearing price will prove successful in their bid. MSQ is issued in 50 kilogram units, while fluid quota is allocated in 20 litre portions.

In 1998, the average price for unused MSQ in Alberta was $31.96 per kilogram of butterfat per year. During the same year, the average price for used MSQ was $30.69 per kilogram of butterfat per year, while fluid quota sold for an average of $537.48 per litre of milk per day (Alberta Dairy Control Board, 1998). The value of fluid milk quota is greater than MSQ quota due to the fact that producers receive a higher price from processors for fluid milk compared with industrial milk. During the past three years, returns to fluid milk were $18.00 to $20.00 higher than for industrial milk.[5] A higher price for fluid quota is also a result of the fact that fluid quota allows a specified quantity of milk to be produced *per day*, where MSQ quota represents quantity *per year*.

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[5] Cameron, Brian. 1999. Personal Communication. Edmonton, Alberta.

CHAPTER 3: DEFINING COMPETITIVENESS

Defining competitiveness at the firm level creates a benchmark for comparing the success of Alberta's dairy producers in an open market economy while examining the impact of various farm characteristics and management techniques. According to West (1993), a problem with applying the concept of competitiveness is that no specific economic criteria to measure the competitiveness of business have been established. As stated by Coffin et al (1993), "the term competitiveness has come to mean many things to many people" (p.460). This chapter discusses various interpretations of a globally competitive position in order to derive a working definition of competitiveness for this thesis.

3.1 ABSOLUTE ADVANTAGE

Early economists explained patterns of trade through the principle of absolute advantage. In application of this theory, exports came from the country whose production costs for a particular good were lower than other countries, at prevailing prices and exchange rates (Houck, 1992). However, as stated by Houck (1992), the logic of absolute advantage fails when it is applied to industries and to nations. Realistically, due to the recognition of available resources and consumer demands, a country could never be an "absolute" exporter, importing zero products.

3.2 COMPARATIVE ADVANTAGE

As opposed to looking at the absolute costs of individual products, David Ricardo in 1817 considered the costs of producing additional units of a particular product in terms of the reduction necessary in the output of other goods (Houck, 1992). In short, the opportunity cost of a domestic commodity is compared to its given international price. A nation will specialize in the industries having the lowest opportunity cost associated with production or whose domestic cost of production is less than comparable international prices.

Houck (1992) identifies domestic specialization as the main catalyst for absolute free trade: "specialization according to comparative advantage permits a nation to produce more export goods than it wants, then trade them for less costly imported goods from all over the world," (p.16). From this, a greater variety of products at cheaper prices are available to consumers and peoples' purchasing power increases. Domestic industries producing commodities with high opportunity costs disappear as markets are lost to imports, and national resources and investment move out of high cost production and into expanding sectors (Houck, 1992). It may be demonstrated that trade through comparative advantage ensures the most efficient allocation of an economy's resources.

The term *competitive* advantage is often used as being somewhat synonymous to comparative advantage. However, according to Barichello et al (1996), "competitive advantage is a more political than economic concept; an industry can have a trading advantage because of subsidies, tax breaks, trade protection or other forms of intervention," (p.98). Barichello et al (1996) contend that in order to determine which nation will produce and export under free trade, a measure of comparative advantage as opposed to competitive advantage is required. Thus, an alternative approach must be used to arrive at a definition of competitiveness that is appropriate for Alberta dairy farms.

3.3 A STRATEGIC MANAGEMENT DEFINITION OF COMPETITIVENESS

West (1987), Hazeldine and Freeley (1991) and Coffin et al (1993) define farm-level competitiveness as the ability to earn profits and maintain market shares. Profitability and market share prove to be the most commonly employed measures of competitiveness at the firm level. However, West (1993) warns that both indicators are influenced by government domestic and trade policies and thus distort a firm's actual competitive ranking. West (1993) provides an example: ". . . a market share maintained by import controls does not reflect fundamental competitiveness nor do small export shares due to a lack of access to foreign markets indicate a lack of competitiveness" (p.7).

One approach to compensate for this distortion is found in a competitiveness framework developed by Martin et al (1991). This framework categorizes factors of competitiveness by the degree to which firms and governments control them. According to West (1993), a firm can control, to at least some degree, its strategy, products, technology, training, research and development, cost and linkages. The government controls the business's operating environment by influencing taxes, interest rates and exchange rates. To assess the "fundamental" competitiveness of a firm affected by government subsidies, West (1993) contends that the examination of trends in the determinants of competitiveness is imperative.

3.3.1 Determinants of Competitiveness

Porter (1990) recognizes six determinants of competitiveness. These determinants, as a system or individually, " . . . shape the environment in which local firms compete that promote or impede the creation of competitive advantage," (p.71). Each is outlined below:

(1) Factor Conditions

According to West (1993), the continual upgrading of a firm's factors of production is a necessity for sustained competitiveness. Porter (1990) identifies natural resources, climate, location, unskilled labour and debt capital as "basic factors" and in contrast, deems communications infrastructure, highly trained personnel and research activities as "advanced factors." Porter (1990) argues that, outside of extractive and agriculturally based industries, basic factors of production are becoming less crucial in influencing competitiveness due to the fact that they are increasingly more accessible in global markets at cheaper prices. Advanced factors are critical for obtaining a competitive edge as they are more scarce than basic factors and more difficult to trade between nations.

(2) Demand Conditions

The composition, size and growth rate of domestic demand has an impact on a firm's competitive position. Porter (1990) states that the composition of domestic demand and pressures from domestic buyers force local firms to be innovative and responsive to consumer needs..The faster and more accurately a firm can adjust in response to changes in the domestic market, the greater its projected advantage on a global level. With respect to the size of domestic demand, Porter (1990) contends that a large and rapidly growing home market facilitate a competitive advantage by encouraging aggressive investment in technology development and productivity improvements. According to West (1993), a small home market or slow growth rate pressures domestic firms to seek export opportunities.

(3) Related and Supporting Industries

As described by Porter (1990), the coordination of related and supporting industries establishes a "value system" for a firm. This value system provides the affiliated firm with efficient, fast and preferential access to cost-effective inputs and innovative production techniques. West (1993) reports that both domestic and international suppliers may comprise a given value system and contribute to activities such as technology development, manufacturing, distribution, marketing and service. Domestic suppliers promote the close working relationships required for process innovation and upgrading. Inputs having little impact on innovation or on product performance are obtained from international sources (West, 1993).

(4) Sector Strategy, Structure and Rivalry

The structure and goals of a national industry govern the operations of the individual firms comprising it. More specifically, West (1993) states that economies of size, the nature of competition among firms, vertical and horizontal linkages, and a firm's exposure to world markets are all dictated by a sector's organization. According to Porter (1990), the rivalry among domestic firms that grows within a particular business environment forces firms to improve and innovate, ". . . to lower costs, improve quality and service, and create new products and processes" (p.118).

(5) The Role of Chance

Chance events are happenings beyond the control of a firm and are often unrelated to a nation's situation. Porter (1990) identifies the role of chance as a key determinant of competitiveness because unexpected occurrences " . . . create discontinuities that allow shifts in competitive position" (p.124). Examples provided by West (1993) of chance events specific to agricultural firms include: political decisions, wars, major changes in consumer preference, the development of new transportation and handling systems, outbreaks of disease, and the weather (p.31).

(6) The Role of Government

According to Porter (1990) the actions of a national government should not be recognized as a determinant of individual competitiveness, but observed in terms of its impact on the previous five determinants. Subsidies, policies and regulations implemented by a government can have both positive and negative effects on the competitiveness of a firm (West, 1993). Porter (1990) argues that government "help" will fail if it removes the pressures on firms to improve and upgrade or if it is the only source of a firm's competitive advantage.

Coffin et al (1993) include costs of production as a seventh determinant of competitiveness. West (1993) states that production costs are a key determinant of competitiveness for homogeneous products with many suppliers. The competitive ranking of a firm can be identified by comparing prices paid for major inputs and observing how they change over time. Incorporating the dimension of time is important when examining a firm's competitiveness: ". . . meaningful measurement of competitiveness must reflect an ability to contend over time with changes in the operating environment which drive rivalry. . . . ," (Coffin et al, 1993; p.462).

For an individual firm the challenge is to choose the optimal approach to competing, given its specific business environment. This environment is to a large extent determined by the described determinants of competitiveness. According to Porter (1985), a firm's competitive ranking is born out of the " . . . value a firm is able to create for its buyers that exceeds the firm's cost of creating it," (p.3). Porter (1990) describes this value as a firm's chosen position within its industry or its competitive strategy.

3.3.2 Competitive Strategy

By choosing a position the firm is indicating its 'approach to competing.' Porter (1990) reveals two competitive strategies a firm may choose from: (1) lower cost; and (2) product differentiation.

> Lower cost is the ability of a firm to design, produce and market a comparable product more efficiently than its competitors. At the prices at or near competitors, lower cost translates into superior returns . . . . Differentiation is the ability to provide unique and superior value to the buyer in terms of product quality, special features or after-sale service. . . . Differentiation allows a firm to command a premium price, which leads to superior profitability provided costs are comparable to those of competitors (p. 37).

Porter (1990) states that it is difficult, but possible for a firm to gain a competitive advantage through both a low cost and differentiated product strategy. The difficulty arises from the fact that a differentiated product, in a majority of cases, has higher production costs as it possesses increased quality and performance. It is suggested that, in the long run, increasing firm technology can simultaneously reduce costs and improve the product.

A third competitive strategy is introduced by Porter (1990), competitive scope, or as identified by Coffin et al (1993), focusing on a niche market. Porter (1990) stresses that no one strategy is necessarily better than the other. A firm's chosen position reflects its individual structure, resource base and goals. The success of one's implemented competitive strategy is dependent upon the way the firm organizes and coordinates its discrete activities through distinguishing management techniques (Porter, 1990).

3.4 A WORKING DEFINITION OF COMPETITIVENESS

The strategic management approach described in the previous section can be used to develop a working definition of competitiveness for Alberta dairy farms. With the high degree of government involvement in Canada's dairy industry, determining the fundamental competitiveness of dairy farmers requires the analysis of trends in the determinants of competitiveness. Because of a) the uniform marketing of milk by dairy producers, resultant of Canada's supply management system, b) the homogeneity of milk production at the farm level, and c) the inelastic nature of domestic milk demand, the most appropriate determinant to evaluate is cost of production. Thus, the working definition of competitiveness employed by this thesis is based on the cost competitiveness of Alberta dairy producers. Specifically, the dairy farm or group of dairy farms achieving the lowest per unit cost of production is identified as being the most competitive.

CHAPTER 4: LITERATURE REVIEW

A significant amount of research has been conducted that examines the cost competitiveness of Canada's milk producers. These have been largely cost of production (COP) studies. A critical analysis of various methods utilized and the results of these studies is presented in this chapter.

4.1 CONSTRUCTING A COST OF PRODUCTION ANALYSIS

Barichello and Stennes (1994) state that for most empirical examinations of business cost competitiveness, costs of production in competitive sectors can in the long run be expected to equal the average market price received. However, this is not true for Alberta's supply managed dairy industry, due to the use of marketing quotas. According to Barichello and Stennes (1994), the average market price of milk in the long run can be expected to equal the sum of annual farm production costs plus the annual cost of holding quota. The authors thus conclude that the appropriate method of obtaining dairy cost of production data for analysis at the farm level is to estimate and aggregate each cost component directly.

4.1.1 Empirical Issues in Using Cost of Production Data

Much controversy exists over the use of cost of production data in analysis, especially when the objective is to conduct interregional comparisons. Stanton (1986) presents the following outline of issues provoking argument among researchers (p.5):

(1) the representativeness of the data and the situations for which costs were presented and the sampling procedures used in collecting data;
(2) the comparability of the enterprises or systems which are studied, including climate, quality differences in the final products, size of enterprise, etc.;
(3) the choice of appropriate currency exchange rates to use in making national comparisons;
(4) a procedure to handle different rates of inflation within individual countries and the choice of appropriate deflators;
(5) agreement on the list of items which are treated as direct and variable costs;
(6) the time period over which production costs are calculated;
(7) the treatment of fixed costs and their relative importance in making comparisons;
(8) mechanisms to recognize government subsidies or special programs which influence prices and costs; and
(9) the economic environment in which production occurred.

Barichello and Stennes (1994) agree that within economic research there is an undeniable frustration with COP studies: "Cost of production estimates from sampled farm data will incorporate both inaccuracies and biases which under some circumstances will be significant. Indeed, some would argue that the exercise of calculating farm costs of production is significantly full of pitfalls that it should not be attempted" (p.3).

To minimize the difficulties inherent in cost analysis, Barichello and Stennes (1994) suggest that the researcher carefully define the nature of the costs. For example, the researcher must indicate whether feed is valued at average annual market prices or at the on-farm cost of production.[6] To alleviate some of the concerns associated with COP analysis, Barichello and Stennes (1994), and Stanton (1986) recommend the pricing of inputs at their supply price or opportunity cost. If on-farm intermediate inputs are used, Barichello and Stennes (1994) state that, depending upon which is lower, a cost reflecting alternative sources of supplying the input or the cost of keeping the required home-produced inputs on the farm should be utilized.

In order to validate the credibility of COP comparisons across nations, components must be expressed in units of a single domestic currency. The chosen currency is typically that of the country whose economic trade performance is of concern. Houck (1992) adds that one may use the major currency in which international assets are held, or alternatively, the currency in which world prices of the commodity in question are normally quoted.

Stanton (1986) emphasizes that when conducting a COP study over a period of several years, changes in the rate of inflation must be taken into consideration. Stanton (1986) notes a debate over which is the correct set of index numbers to use in cost analysis. Some argue that price deflators of GDP or GNP are the most appropriate as they are the most basic indicators of price movements. Others contend that using a series based on prices paid by farmers is accurate. Stanton (1986) discourages the latter, claiming that a majority of agricultural economists view this procedure as inappropriate due to the fact that a number of the items included in the index are also components of the cost of production series being studied.

Finally, in order to further improve the status of COP studies, Barichello and Stennes (1994) suggest that economic rents should be excluded from any analysis as these are not costs. In an example, the authors define the return to management as an economic rent that is available to better managers, and is therefore not a component to be calculated in a COP analysis. A second example would be the economic rent associated with production quota and the capitalization of the quota into the farm's fixed assets.

4.1.2 Impediments in Using Farm-Level Dairy Cost Data

Barichello and Stennes (1994) point out that following the guiding principle of opportunity cost and adopting the stated suggestions in dealing with cost data will not necessarily produce a flawless depiction of dairy cost competitiveness. This is because the use of farm level data typically leads to overstated cost estimates. Barichello and Stennes (1994) report six reasons for this result, each of which is summarized below.

First, most farm-level data are collected for the purpose of determining milk prices. Specifically, this provides an incentive for producers to provide cost estimates that are biased upwards.

Second, costs are often recorded for tax purposes as opposed to reasons related to management decisions. This is particularly true for smaller dairy operations. The net result is an error in cost calculations, as there are differences in both the amounts and types of costs reported for taxes versus "true" enterprise costs.[7]

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[6] For further details on calculating individual cost components see Barichello and Stennes (1994).

Third, Barichello and Stennes (1994) state that segments of primary farm production often have a significant percentage of total variable inputs as value-added activities; that is, non-purchased raw materials. As a result, quantification and valuation of farmer-owned inputs is required. This involves a procedure that is subject to considerable error, when compared to the valuation of purchased inputs.

Fourth, prices for farmer-owned inputs, predominately the supply of operator labour, will vary across farm enterprises. Barichello and Stennes (1994) credit regional differences, alternative skills of farm operators or varying degrees of a farmer's preference for working in agriculture as contributors to this variation. The authors expand on this point, recognizing that the problem is at its greatest among small farms:

> Labour costs are dominant on those farms, and they remain competitive by virtue of their low (i.e., family) labour costs . . . the only means for such farms to avoid making losses at current prices is for family labour to be valued at low wage rates. . . . Therefore, it is not surprising that the cost data above, valuing all labour at the hired wage (family labour at 66% of hired labour), places small farms at unit costs levels which are not only the highest of all farm categories, but significantly above unit prices they receive, an impossibility in anything but the shortest of time periods (p.5).

Fifth, valuing farm machinery, equipment and buildings at new prices when calculating depreciation will result in exaggerated depreciation values. Barichello and Stennes (1994) explain that an inventory of all new capital is not typical of the average farm.

The final difficulty in dealing with farm data is that average farm costs are used instead of long run marginal costs of the operation. Barichello and Stennes (1994) state:

> Under any policy change the relevant costs for industry change are those of the farms which are staying in the industry, those responding by changing production levels or those entering the industry- farms active at the margin of production. However, in addition to

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[7] An example of this is the use of Capital Cost Allowance (CCA) as a proxy for depreciation.

> such farms, there are a number which, for reason of operator age, small size, outdated management or technical skills, or other cause of high costs and lower production, are most likely to exit . . . . (p.5).

Because relatively uncompetitive dairy farms may be included in average cost data, the overall data is given an upward bias. It is suggested that grouping of operations according to size or net farm income would aid in correcting this problem.

Despite these six difficulties, which are unavoidable when using farm cost data, Barichello and Stennes (1994) maintain the usefulness of cost analysis in bench-marking the competitiveness of milk production. They defend this method, acknowledging costs to be more commonly exaggerated among small farms and small regions and that the stated problems will be "experienced in all areas or times periods" (Barichello and Stennes, 1994; p.4).

4.1.3 Related Studies

In their 1994 study of the cost competitiveness of the Canadian dairy industry, Barichello and Stennes derived costs of production for producers in Quebec, Ontario, Alberta, Wisconsin, New York and California. The researchers found variable costs to comprise the greatest portion of total costs (62 percent) incurred by Alberta's dairy farms. Variable cost per hectolitre in Alberta was significantly higher than those calculated for Quebec and Ontario. However, fixed costs and unpaid labour costs for Alberta operations were substantially lower in comparison. A similar result was found for the American regions examined in the study. California had the greatest unit variable cost, but lower fixed costs and unpaid labour expenses relative to Wisconsin and New York. Barichello and Stennnes (1994) concluded this to be the result of scale differences, as similar herd sizes in all regions had similar costs per hectolitre: "Despite the extra variable costs that appear to arise with large sized operations, the potential savings in fixed costs and unpaid labour is large enough to give cost advantages to larger farms" (p.19).

Overall, the results of Barichello and Stennes (1994) show total costs of production to be highest in Ontario ($43.36/hl) and Quebec ($44.21/hl) and lowest in California ($28.24/hl). Alberta exhibited the lowest Canadian total average cost, at $35.88 per hectolitre. This is slightly more than 10 percent higher than in New York and Wisconsin.

Ross et al (1998) compared recorded costs of production for Quebec, Ontario, Manitoba and Alberta dairy farms for the years 1992 to 1995. With the exception of 1993, Ontario displayed a slight cost advantage over Alberta. Manitoba had the lowest total cost per hectolitre in each of the four years examined. The researchers credit this finding to the fact that in each observed year, Alberta had significantly higher costs for purchased feed and capital than in the other provinces. Ross et al (1998) report Alberta as having the lowest labour expense from 1992 to 1995.

The results reported by Ross et al (1998) conflict with Barichello and Stennes (1994) who concluded that Alberta was the most cost competitive dairy region in Canada. The answer to this inconsistency lies in the data utilized by Ross et al (1998). According to Ross et al (1998), their cost estimates for Quebec, Ontario and Manitoba came from the CDC's annual national cost of production studies. The data representing Alberta were obtained by an alternative source, the province's Production Economics and Statistics Branch. As pointed out by Ross et al (1998), ". . . the CDC survey is aimed more at the larger efficient low cost dairy farms. Farms must ship at least 60 percent of the average annual farm production to qualify for inclusion in the sample," (p.41). The Alberta cost data, on the other hand, mirror the provincial industry average. With respect to labour, the CDC includes the costs incurred by operations in their crop and forage production. Operator and family labour reported in the Alberta cost data are valued at industry wage rates and represent only the hired labour expense for the dairy enterprise. Following the logic of economies of size, it makes sense that Alberta would display an overall cost disadvantage and at the same time sustain a low labour cost. The discrepancy observed between the 1994 study of Barichello and Stennes and the work of Ross et al (1998) demonstrates the sensitivity of COP analysis. It reinforces the importance of use of compatible data in comparisons of costs of production.

In their 1998 study, Ross et al also make a comparison between 1994 costs of production computed for Alberta dairy farmers and those incurred in the same year by producers in six different regions of the United States. Ross et al (1998) report average total production costs to range from $53.17 and $54.70 per hectolitre in the north east, south east, upper midwest and corn belt regions. The southern plains and pacific regions had the lowest costs of production at $46.92 per hectolitre and $40.74 per hectolitre, respectively. The researchers determined Alberta dairy producers to operate at a COP value of $45.71 per hectolitre, thereby realizing the second lowest total production costs. According to Ross et al (1998), this standing is a result of Alberta having a cost advantage of $6.00 to $7.00 per hectolitre in feed costs. Ross et al (1998) do not reveal how the feeds costs for American farms were calculated; however, this finding makes sense when one considers the fact that Alberta is a major feed grain producer and that the majority of feed utilized on the large United States south western dairy operations is purchased from out of state.

A recent study of Alberta milk production reports costs of production for the province's dairy producers rose $0.69 per hectolitre to $52.99 per hectolitre in 1998, an increase of 1.33 percent over the previous year (Kotowich et al, 1998). Kotowich et al (1998) conclude that this is a result of fixed costs increasing from $11.63 per hectolitre $13.04 per hectolitre during the 1998 dairy year. The authors found total feed costs to have declined from $20.79 per hectolitre to $19.63 per hectolitre from 1997 to 1998. It is of interest that each component of total feed expense: grain, complete feed, supplement, minerals and vitamins, roughage and processing costs, decreased. This is not consistent with the dry and slow growing season in 1998 reported by Kotowich (1998). Perhaps large on-farm stocks of feed remaining from a record harvest of forage and hay in 1997 sustained the decreased quality and quantity of the 1998 crop. Producers increasing rotational grazing into their management practices may be a second explanation for this finding.

4.2 PROFITABILITY

When the revenue of individual farms is considered in cost analysis, the profitability of dairy producers can be assessed. Ruch et al (1992) define profitability as "the ratio of total revenue to total cost; indicates the percent of revenue that covers the costs of resources and the percent that goes to profit," (p.291). In accounting terms, net farm income is the measure of profit determined by subtracting total annual expenses from total annual revenue.

In practice, profitability is the result of a farm's management decisions. It is directly related to an operation's success or failure in achieving low cost production. According to Lazarus et al (1989), large farms will be more profitable than small farms as economies of size spread overhead costs over more producing units. Lazarus et al (1989) identify age of the farm operator, debt load, form of business organization, and the educational level of the operator as the major determinants of profitability. However, one must take caution in utilizing profitability as a means to predict Canada's cost competitiveness in an open market economy.

Jeffrey (1992) calculated net returns per litre of milk produced on Canadian and American farms. The results indicated that, in the late 1980's, Canadian province, with the exception of Manitoba and Saskatchewan, generated a net return of between $0.12 and $0.15 per litre. This was substantially higher than for American producers who received a net return of $0.034 to $0.096 per litre. From this, Jeffrey (1992) concludes Canadian farmers are compensated for higher costs of production by higher milk prices.

Ross et al (1998) reported Alberta as having a return to equity of $10.30 per hectolitre while returns to equity computed for the United States varied from a low of -$8.43 per hectolitre in the upper midwest to a high of -$0.09 per hectolitre in the pacific region[8]. According to Ross et al (1998), Alberta's 1994 blend price for milk was $51.03 per hectolitre, $14.21 per hectolitre higher than the average price received by producers in the United States pacific region.

As a result, due to producer price guarantees under the nation's supply management system, it is not recommended that net income be adopted as an indicator of the economic well-being of Canadian dairy producers when direct comparisons of current costs of production are made with the United States. However, in the event that a simulation of various international milk prices is carried out, which assumes supply management no longer defines the policy environment of the Canadian dairy sector, profitability would provide an appropriate estimate of a farm's financial position.

Grant (1998) tabulated changes in the net farm income of Nova Scotia dairy farms using 1995 milk prices representative of New Zealand, three American regions and the United States 1995 average price of milk. Grant (1998) concluded that Nova Scotia dairy producers, at current costs of production, are noncompetitive at each international price as a negative average net farm income was found for all herd sizes. The sample group representing the province's largest dairy operations, 75 head and over, sustained the smallest average net loss at each stated price.

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[8] Net income and return to equity calculations are reported in Canadian dollars per hectolitre.

4.3 INCORPORATING EFFICIENCY

Richards and Jeffrey (1996), unwilling to dismiss the difficulties inherent in using farm cost data, conclude that producer efficiency and its relationship with production costs is a more appropriate measure of competitiveness than simply comparing average total costs of production. The researchers claim that producer efficiency provides an explanation for differences in farm costs and therefore facilitates the development of a strategic plan for the business to follow.

Ruch et al (1992) credit increased efficiency for decreasing the effort, quantity of materials, and time required in the production of a given level of output, and as a result, generating greater benefits for all involved. Bravo-Ureta and Rieger (1991) state that "efficient farms are more likely to generate higher incomes and thus stand a better chance of surviving and prospering," (p.421). Phillips et al (1989) contend that "the most efficient production process would have the lowest cost per unit. Those producers with lowest cost possess an absolute advantage over competitors," (p.3). Hence, incorporating efficiency measures into cost analysis is vital in determining the cost competitiveness of Canadian dairy producers in a changing dairy policy environment.

4.3.1 Technical and Economic Efficiency

According to Jeffrey (1992), there exists within economics various interpretations and applications of efficiency. In examining the performance of the dairy sector, technical and economic efficiency are the most commonly applied concepts (re: Bravo-Ureta, 1986; Bravo-Ureta and Rieger, 1991; Jeffrey, 1992; Richards and Jeffrey, 1996). The foundation for measuring efficiency was laid by Farrell in his 1957 paper, 'The Measurement of Production Efficiency.' He proposed an index measure whereby economic or total efficiency is the product of technical and allocative efficiency. Black (1997) defines technical or physical efficiency as "efficiency concerned with getting the largest possible outputs for given inputs, or the smallest possible inputs for given outputs. This is efficiency in production," (p.463). Allocative efficiency is defined by Richards and Jeffrey (1996) as "the producer's ability to respond to economic signals and choose optimal input combinations (i.e., proportions) given relative input prices. . . ." (p.4). Thus, economic efficiency, as defined by Jeffrey (1992) is "the ability to choose the technically efficient output/input combination that optimizes a decision-maker's goal(s), given relative output and input prices" (p.3). Jeffrey (1992) states that in studies of the economic efficiency of dairy producers, the goal is usually assumed to be minimization of total production costs.

4.3.2 Empirical Examination

The empirical method adopted for assessing firm efficiency, according to Jeffrey (1992), is dependent on the type of efficiency being considered and the availability and consistency of data. Below is an outline of various methodologies utilized by researchers to determine the efficiency of dairy producers and the results obtained.

Matulich (1978) employs an economic-engineering approach to assess efficiencies in large-scale California dairy farms. Specifically, Matulich (1978) separates farm operations into three technical stages: milking, housing and feeding. Using market prices, input-output relationships in each stage, for each farm observed, were pooled into representative groups of various herd sizes. Short-run and long-run cost functions were then derived for each group. Bravo-Ureta (1986) dismisses the findings of studies using the economic-engineering approach, claiming the method is only a reflection of the actual farm situation to the extent that the specific assumptions are met.

A 1990 study by Weersink et al looks at the technical efficiency of a cross section of Ontario dairy farms. More specifically, overall technical efficiency, pure technical efficiency, relative output loss due to input congestion and scale efficiency are calculated.[9] Following the approach of Fare et al (1985), Weersink et al (1990) employ a deterministic, non-parametric approach to measure efficiency levels. A set of linear programming models for each of the observed farms is solved, deriving efficiency by evaluating the given operation's input and output relation relative to all other farms in the sample. The authors argue that using this method, as opposed to a stochastic, parametric approach, allows for the relaxation of the assumption of constant returns to scale:

> Without these restrictions, the approach can identify the magnitude of technical efficiency and decompose the resulting measure into purely technical, congestion and scale efficiency terms. . . . Without requiring a parametric specification of the functional form for the frontier, unwarranted structure is not imposed on the technology, thereby preventing a distortion in the efficiency measures (p.440).

Weersink et al (1990) conclude that a high level of technical efficiency exists on Ontario dairy farms. The authors observed an average overall technical efficiency value of 91.8 percent, with 43 percent of sampled farms operating at full efficiency. Weersink et al (1990) claim overutilization of inputs to be a minor cause of inefficiency as input congestion was found in only 3 of the 60 inefficient dairy farms.[10] They conclude that pure technical allocation and an improper scale of the dairy enterprise are the major sources of inefficiency. Weersink et al (1990) state that as herd size increases, the level of total efficiency per farm increases, while the variability of calculated efficiency decreases. In accordance with the research of Grisley and Mascarenhas (1985), Weersink et al (1990) credit uniform management practices and technology found on larger farms for this finding.

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[9] Weersink et al (1990) describe pure technical efficiency as a measure of technical efficiency where constant returns to scale is not imposed on the level of technology of a given farm. Scale efficiency is defined by Weersink et al (1990) as overall technical efficiency divided by pure technical efficiency.

[10] According to Weersink et al (1990), "input congestion occurs when the marginal product

Average levels of pure technical efficiency computed by Weersink et al (1990) were found to be lower than the average level of scale efficiency for individual farms. However, the total number of farms demonstrating technical efficiency was larger than the total number of scale-efficient farms. These results cause Weersink et al (1990) to conclude that "... small farms are combining resources properly but farm size needs to be increased," (p.449).

The findings of Weersink et al (1990) are somewhat misleading because calculated levels of efficiency are determined within a closed system of linear equations. According to Phillips et al (1989), a cost competitive analysis should involve the determination of regional efficiency by means of a cross-country production function or an input-output analysis.

Phillips et al (1989) adopt an input-output approach, arguing that with an input-output accounting framework, all factors of production are recognized. Phillips et al (1989) states that the major limitation of this approach is a bias which may develop over time due to changing relative factor prices and relative weights of factor inputs. However, the authors contend that this concern can be alleviated if examination occurs in the short run. Phillips et al (1989) add that a problem of large year-to-year fluctuations in output volume may also surface. With respect to Canada, they do not see this as an issue due to a consistency in supply promoted by the nation's supply management system.

Jeffrey (1992) also utilizes an input-output approach of farm accounting data to determine the technical and economic efficiency of dairy farms in selected regions of Canada and the United States. Jeffrey (1992) argues that employing this farm management approach in analysis has an advantage over econometric and mathematical programming approaches because it is less data intensive and is less complicated to implement and interpret.

Jeffrey (1992) concludes that American dairy farms, having greater milk production per cow and greater labour productivity, are more technically efficient in comparison to Canadian dairy operations: "Washington has the greatest milk production per cow (8626 litres) while Manitoba has the lowest (5984 litres). All four American farms have greater production per cow than British Columbia, which has the greatest production per cow of the Canadian farms" (p.11).[11] A similar conclusion was reported by Phillips et al (1989) in a study comparing milk production in New Brunswick, Ontario, Quebec, the Netherlands and the United States. The authors found that producers in the upper midwest realized greater milk production per cow than their Canadian counterparts.

With respect to labour productivity, Jeffrey (1992) found that each of the American

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of an input is negative," (p.444).

[11] Jeffrey (1992) is referring to four American states which are examined: New York, Minnesota, Washington, and California.

states examined in the study generated a higher level of the ratio of the number of cows per worker equivalent than for any of the Canadian provinces under consideration.[12] Values ranged from a high of 75 cows per worker equivalent in Washington to 43 cows per worker equivalent in Minnesota. Manitoba had the highest labour productivity in Canada, at 38 cows per worker equivalent. Quebec, realizing only 30 cows per worker equivalent had the lowest overall labour productivity.

In comparing economic efficiency levels, Jeffrey (1992) also concludes that American farms are performing better than Canadian farms. In terms of variable costs, Jeffrey (1992) found all four American states to have a cost advantage over their Canadian counterparts. Of all the regions evaluated in this 1992 analysis, farms in New York had the lowest variable costs per litre of milk produced ($0.27/litre), while those in Ontario realized the greatest ($0.330/litre).

When economic efficiency is measured as total costs per litre of milk produced, Jeffrey (1992) concludes California to be the most efficient, with total costs at $0.293 per litre. Saskatchewan was found by Jeffrey (1992) to have the least efficient production with total costs equaling $0.486 per litre. Again, Canada was found by Jeffrey (1992) to have a less efficient dairy sector in comparison to the United States. Alberta, with total costs of production at $0.374 per litre, had the lowest costs of any Canadian province observed.

When evaluating economic efficiency as feed costs per litre of milk produced, Jeffrey (1992) concludes dairy operations in Ontario and New York to be the least efficient with feeds costs of $0.217 per litre and $0.212 per litre respectively. Jeffrey (1992) found British Columbia ($0.129/litre) and Alberta ($0.159/litre) to be the most economically efficient overall with the lowest feed costs per litre of milk produced. The feed costs used by Jeffrey (1992) were valued using on-farm costs of production. Phillips et al (1989) on the other hand, calculated feed efficiency using purchased feed prices. Phillips et al (1989) argue that this method provides a measure of a farm's dependence on off-farm resources. The results of Phillips et al (1989) show that New Brunswick producers pay $13.71 per hectolitre for purchased feeds. The Netherlands and Quebec face a purchase price of $11.96 per hectolitre and $7.68 per hectolitre, respectively. The United States upper Midwest and Ontario farmers are much less dependent upon purchased feeds, paying $5.86 per hectolitre and $4.57 per hectolitre respectively. The cost of purchased feeds measured in New Zealand was $0.61 per hectolitre. This comparatively low figure can be explained by the fact that in New Zealand, milk is largely produced using grazing of pasture with associated on-farm produced hay for supplementary feeding.

A correlation between costs of production and economic efficiency measured in terms of labour costs per litre of milk produced was detected by Jeffrey (1992). The researcher reports California and Washington to be the most labour efficient with low labour costs and high labour productivity, while Canadian dairy farms are less efficient. Due to the fact that herd size of each representative region examined by Jeffrey (1992) increases moving from eastern to western Canada and moving from Canada to the United States (the exception is

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[12] Jeffrey (1992) defines a worker equivalent as 3000 hours of labour.

Minnesota which has a herd size comparable to British Columbia), Jeffrey (1992) concludes that "relative labour productivity and cost seem to be directly related to herd size," (p.14). Jeffrey (1992) claims these "herd size efficiencies" to be a result of different technologies utilized for milking and feeding.

4.4 ECONOMIES OF SIZE AND ECONOMIES OF YIELD

Several of the competitiveness studies reviewed above report economies of size to exist in the dairy industry. According to Binger and Hoffman (1998), economies of size result when the minimum unit cost associated with using a particular production process can only be achieved when a substantial number of units of the good are produced. In other words, the larger a herd size, the more cost competitive its position in the dairy industry. Barichello et al (1996) note that the existence of economies of size in the dairy industry is generally agreed upon among agricultural economists. These authors indicate that several studies conclude economies of milk yield also exist in the dairy industry; that is, there are studies indicating that average costs of production will decrease as milk production per cow is increased. Barichello et al (1996) contend that average yield per cow increases when herd size increases: "This suggests that lower COP results not merely from an increase in farm size, but also from an increase in yield per cow or a combination of these two factors" (p.108). Barichello et al (1996) argue that this hypothesis has not been properly addressed as cost competitive studies have not taken into account the fact that the distribution of milk yields may vary with farm size when establishing a relationship between COP and farm size. A limitation of many cost competitive studies, according to Barichello et al (1996), is the omission of technical and allocative efficiency measures and how they relate to economies of size and economies of yield.

4.4.1 Farm Costs of Production as Related to Economies of Size and Yield

In a 1996 study of the Quebec and Ontario dairy industries, Barichello et al analyze the impact of farm size and milk production per cow on farm production costs. Surveyed farms were subdivided into groups according to herd size and milk yield per cow. First, Barichello et al (1996) contrast cash costs, COP, labour productivity, interest and depreciation, on a per hectolitre basis, between each herd size category. It was found that for those farms milking less than 50 head, in both Quebec and Ontario, average production per cow does not increase significantly with increased herd size.

In Quebec, average cash costs were found to be higher for herd sizes of less than 30 cows compared to all other herd size subgroups. Differences in average cash costs for Ontario farms were only statistically significant between small farms (i.e., less than 35 cows) and large farms (i.e., more than 50 cows). With respect to average total costs of production, the same trend was found as only small dairy operations showed significantly higher costs in comparison to all other herd sizes. Barichello et al (1996) concluded interest payments to be consistent between all farm operations in Ontario, while larger farms in Quebec had higher interest payments than small operations. The authors state that depreciation costs decreased with farm size up to 40 cows, than increased for farms milking 41 to 50 cows and decreased again for larger dairy farms. Barichello et al (1996) report increased labour productivity with increased farm size.

Second, Barichello et al (1996) compare the cost stated above and labour productivity between each yield grouping. When examining farms in Quebec, Barichello et al (1996) found that cash costs and total COP decreased as yield per cow increased only on those farms milking less than 50 cows. In Ontario, there was no evidence of economies of yield. As with increasing farm size, labour productivity was found by Barichello et al (1996) to increase with volume of milk production per cow.

4.4.2 Efficiency as Related to Economies of Size and Yield

In order to investigate the relationship of a farm's technical and allocative efficiency with economies of size and economies of yield, Barichello et al (1996) constructed a production function representing primary milk production in Quebec and Ontario. Yield per cow is identified as the dependent variable and forage per cow, grains and protein supplements per cow, number of labour hours per cow, and the value of dairy equipment per cow are used as the independent variables. Barichello et al (1996) explain that following the initial estimation of this production function, farms meeting a desired level of milk yield per cow are used in a second estimation of the production function. According to the researchers, the process is repeated until the production function is a representative of only the most efficient dairy operations in each province. A "potential yield per cow" is then estimated for each farm. A technical efficiency index is calculated for every farm in the sample by the ratio of actual yield per cow to potential yield per cow. Each efficiency index is compared to labour productivity and COP. Barichello et al (1996) simply conclude that ". . . cash costs and COP are not affected by the size of the farm when the level of efficiency is taken into account" (p.111).

With respect to levels of efficiency and milk yields, Barichello et al (1996) state that when moving from high cost to low cost producers, in Quebec and Ontario, technical efficiency increases, but potential production decreases. Also, average yield per cow was low for small herd sizes, but no difference in yield existed between average and large sized herds. Because of this two findings, Barichello et al (1996) report ". . . farms with higher costs could lower their cash costs and also increase yield per cow by using inputs more efficiently. However, farms have lower COP more as a result of their efficient use of production factors than high yield per cow" (p.111).

4.5 EMPLOYING A COST COMPETITIVENESS STUDY

The literature reviewed in this chapter provides the framework for which to build a methodology to assess the cost competitiveness of Alberta dairy farms. The essential elements of a cost competitiveness study which are to be adopted by this thesis are summarized below. When the cost competitiveness of primary dairy producers is assessed by way of a COP study, the researcher must be aware of the difficulties inherent in using farm cost data. Defining the nature of cost components and the pricing of inputs at either their supply price or opportunity cost is vital. It is suggested that to ensure consistent data collection of farmer-owned inputs, predominately the supply of labour, uniform labour time sheets and cost questionnaires be distributed to producers. Because farm data is presented in terms of average costs and not long run marginal costs, it is recommended that examined farms be divided into groups according to size or net return. The fact that farm data are essentially upwardly biased is accepted by virtue of this bias occurring over all areas and time periods.

In choosing a methodology to compare the cost competitiveness of Alberta dairy farmers with other countries, a profitability framework is discouraged as Canada's guaranteed milk prices compensate for the country's higher production costs. However, in the event that a simulation of various international milk prices is carried out, which assumes supply management no longer defines the policy environment of the Canadian dairy sector, profitability would provide an ideal estimate of a farm's financial position.

Incorporating measures of efficiency into a COP study can possibly provide an explanation for differences in production costs. Due to its ease of implementation and interpretation, an empirical model employing a farm management approach is recommended to compute the technical and economic efficiency values of dairy farms. The major limitation of employing this methodology is a bias which may develop over time due to changes in factor prices. However, this concern can be alleviated if examination occurs in the short-run.

The majority of the studies reviewed in this chapter conclude economies of size to be the central determinant of cost competitiveness within the dairy industry. A less accurate inference on the presence of economies of yield in the industry was made. In light of this, no assessment of dairy competitiveness at the farm-level can be considered complete without incorporating an examination of the role of herd size and milk yield in milk production.

CHAPTER 5: ISSUES OF METHODOLOGY AND DATA

5.1 METHOD OF ANALYSIS

The methodology employed here to assess the competitive position of Alberta's primary dairy producers is based upon a farm management approach to analysis of cost and revenue data. In order to incorporate the dimension of time into the analysis of this thesis research study, and to observe changing trends in the operating environment of Alberta's dairy producers, COP data for three consecutive years are examined: 1994, 1995 and 1996. Three complementary analyses are performed on each set of annual data to facilitate a more concise assessment of competitiveness of producing milk in Alberta at the farm level. Each method adopted is explained in detail below.

5.1.1 Grouping Farm Data for Analysis

As indicated by Barichello and Stennes (1994), one of the problems associated with using farm cost data is the focus on average costs rather than long run marginal costs. Inclusion of high cost producers results in an upward bias to average cost calculations (Barichello and Stennes, 1994). To alleviate this problem, and also to determine if economies of herd size and/or economies of yield exist among the province's dairy farms, each annual data set is divided into groups based on milking herd size. A second data division groups operations according to farms' average production per cow.

To determine the appropriate point of division for each subgroup of herd size, the distribution of the total number of milking cows per farm for 1994, 1995 and 1996 was mapped onto a histogram.[13] The resulting histogram displayed an asymmetrical distribution of data. More specifically, milking herd sizes contained in the three annual data sets were positive or right-skewed. As revealed by Berenson and Levine (1996), data found to be right-skewed represent a mean which is greater than the median: ". . . the mean is increased by some unusually high values," (p.127).

Due to the fact that a symmetrical distribution of milking herd sizes was not observed, an adhoc or random grouping of the farm data is inappropriate. Thus, the clustering of farm herd sizes was examined in order to determine how to form subgroups. Three distinct groupings of farm herd sizes were found to exist. The first cluster was found at a herd size of 40 to 50 milking cows. A second concentration of farm herd size data was observed at 50 to 70 head of milking cattle. The third and final accumulation of farm herd size data was found at 90 head and above. These three explicit clusters of farm herd size data were employed to represent three study groups of Alberta dairy farms. Thus, farms milking between 40 and 50 cows are taken to be representative of the province's small dairy farms (Group H1). Average size dairy operations in Alberta are represented by farms within each annual data set milking between 50 and 70 head (Group H2). The farms reporting over 90 head reflect the province's large dairy enterprises (Group H3). The largest herd sizes included in Group H3's annual data set for the 1996, 1995, and 1994 dairy years were 167 milking cows, 180 milking cows, and 176 milking cows respectively.

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[13] The distribution for Alberta dairy herd sizes for the 1994, 1995 and 1996 dairy years is provided in Appendix A.

It is interesting to note that these groupings of herd size represent differences in the level of technology employed within the Alberta dairy industry. Farms comprising the small herd size group are likely to have a tie stall milking system with grazing and round bail silage as the fundamental components of their feeding program. These farms milking between 40 and 50 head would have no more than 2 or 3 tractors. Farms in the average herd size grouping represent a transition stage of farm technology. More specifically, farms milking 50 to 70 head could have a tie stall set-up or a small milking parlour (i.e. a double 4). These herds would operate with approximately 4 tractors and 1 to 2 tower silos. Farms in the large herd size group would have a large milking parlour (i.e. a double 10 to a double 18) with a free stall system for housing cows. On these farms where over 90 head are milked, 4 to 6 tractors would be found. Large farms are more likely to use bunker silos due to the higher level of maintenance required by tower silos.

The procedure described above was also carried out to determine the most appropriate point of division for subgroups of milk yield. Specifically, the distributions of hectolitres of milk produced per cow per farm for 1994, 1995 and 1996 were determined by means of histograms.[14] Unlike the size of milking herds, recorded production per cow appeared to be symmetrically distributed. According to Berenson and Levine (1996), such symmetrical distribution of data indicates that "... there are no really extreme values in a particular direction so that low and high values balance each other out," (p.127).

Since farm milk yield exhibited a symmetrical distribution, an adhoc grouping of farm data according to production per cow was acceptable. To correspond with the three study groups of herd size, three divisions of milk yield were derived. The first study group was comprised of all farms realizing average production per cow of less than 80 hectolitres of milk (Group M1). The smallest production level recorded for this group of low yielding farms was 57.95 hectolitres per cow in 1996, 57.18 hectolitres per cow in 1995, and 59.50 hectolitres per cow in 1994. The second study group contained all dairy operations reporting an average milk yield between of 80 and 90 hectolitres per cow (Group M2). The third study group consisted of all farms achieving an average production level reported to be greater than 90 hectolitres of milk per cow (Group M3). The high producing group, M3, saw milk yields range as high as 107.66 hectolitres per cow in 1996, 103.09 hectolitres per cow in 1995, and 110.12 hectolitres per cow in 1994.

Applying these groupings, each of the following analyses is performed twice on each annual set of data. First, empirical examination of annual data is made with farms divided according to farm herd size: small versus average versus large. This allows for an investigation of the role of scale in Alberta's dairy industry. Second, in order to examine the potential relationship between milk yield and farm economic performance, an assessment is made of data organized according to farm production per cow: low versus average versus high.

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[14] The distribution of hectolitres for milk produced per cow for the 1994, 1995, and 1996 dairy years is displayed in Appendix A.

5.1.2 Dairy Costs of Production

The economic costs of producing milk at the farm level in Alberta are estimated for each category of herd size and milk yield within each set of annual data. Imputing economic costs is one of four ways by which the financial well-being of farm enterprise can be evaluated from a cost of production perspective. The four main approaches are denoted by the manner in which unpaid family labour is handled within a cost analysis: (1) determining the return to family labour; (2) determining the return to equity invested in a given enterprise; (3) determining the accounting costs of a dairy operation; and (4) determining the economic profit of a farm. The difference between these four methods lies in the definition of net income.

In the first approach, a dollar value for owner's equity is computed and subtracted, along with other expenses, from gross income to establish net return (loss). As unpaid family labour is not a calculated operating expense, net income is expressed as the residual return to labour. Farm economic well-being is thus viewed in terms of dollars of revenue per hour of labour contribution by the farm family. The second approach represents the opposite case where a dollar value for unpaid family labour is subtracted from gross income and net income is expressed as the residual return to owner's equity. Adopting the third method, a cost accounting approach to determine a farm's financial position, no value for family labour or owner's equity is identified. Net income is expressed as the residual return to owner's equity and labour. Finally, when economic costs of production are derived, an estimation of both owner's equity and family labour is made. Here net income is referred to as economic profit and is equal to the gross revenue of the dairy enterprise minus imputed family labour expenses and owner's equity.

It must be emphasized that this study does not estimate an industry cost function. Instead, these estimations compare particular points on the industry cost curve. Differences in the economic costs of production imputed across study groups and across years are tested for significance by performing a single factor analysis of variance (ANOVA) using the computer software package *Microsoft Excel*. If a statistically significant difference is detected by an analysis of variance comparing all three categories of herd size, or all three categories of milk yield, three additional ANOVAs are performed in order to reveal the basis of the significant difference. For example, if the 1996 hired labour cost for small, average, and large herd sizes is found to differ significantly, an ANOVA will be conducted to compare the hired labour expense incurred by the small and average herd sizes (Group H1 and Group H2). A second ANOVA is then run to determine if the hired labour cost of the small and large herd sizes differ significantly (Group H1 and Group H3). Finally, a third ANOVA is performed to examine if a statistical difference in hired labour costs exists between average sized herds and the province's largest dairy operations (Group H2 and Group H3).[15]

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[15] Instead of performing a secondary set of ANOVA tests, the Tukey-Kramer Procedure is

As defined by Black (1997), variance is "a measure of dispersion. The variance of a set of N numbers is found by adding the squares of their deviations from their mean value, and dividing by N," (p.494). The null hypothesis of ANOVA assumes that each population being examined has equal variance, thus there exists no difference in population means. The alternative hypothesis is of course the opposite case where it is assumed that not all population means are equal. Equations 5.1 and 5.2 display the null and alternative hypothesis in their empirical form:

$$H_0: \mu_1 = \mu_2 = \mu_3 \ldots = \mu_n \qquad (3)$$

$$H_1: \text{Not all } \mu_n \text{ are equal (where n = 1, 2, 3, . . . , n).} \qquad (4)$$

Black (1997) describes the procedure of an analysis of variance as follows:

> A statistical technique based on decomposing the overall variance of some characteristic of a population into parts correlated with other characteristics, and residual variation. In particular, analysis of variation is used to test whether sections of a population appear to differ significantly in some property. . . . The overall variance of the population is analyzed into the part due to differences within regions, and the part due to differences between regional means. The larger the proportion of total variance due to differences between group means, the higher the probability that the groups are really different; whereas the higher the proportion of overall variance due to within-group variance, the more likely it is that apparent differences between group means arise from sampling error (p.11).

Berenson and Levine (1996) state that the *overall* or *total variation* is referred to as the sum of the squares total (SST) and is statistically found by ". . . summing the squared differences between each individual observation and the overall or grand mean . . . that is based on all the observations in all the groups combined," (p.529). Equation 5 reveals the mathematical formulation for total variation as provided by Berenson and Levine (1996):

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recommended as a more efficient approach to determine the source of the identified variation.

$$SST = \sum_{j=1}^{c} \sum_{i=1}^{n_j} (X_{ij} - \bar{X}^{G})^2 \qquad (5)$$

where	X_{ij}	is the ith observation in subgroup j,
	n_j	is the number of observations in group j,
	n	is the total number of observations in all groups,
	c	is the number of subgroups of the factor of interest,
	$\bar{X}^{G}$	is the overall or grand mean = $\dfrac{\sum_{j=1}^{c} \sum_{i=1}^{n_j} X_{ij}}{n}$

The *between-group* or *among-group* variation, according to Berenson and Levine (1996), is a result of treatment effects and is obtained by summing the squared difference between the sample mean of a given subgroup and the total variation mean, as weighted by the sample size of each subgroup. The following equation represents the statistical derivation of among-group variation (SSA) following Berenson and Levine (1996):

$$SSA = \sum_{j=1}^{c} n_j (\bar{X}_j - \bar{X}^{G})^2 \qquad (6)$$

where	c	is the number of subgroups being examined,
	n_j	is the number of observations in each subgroup,
	$\bar{X}_j$	is the sample mean of group j,
	$\bar{X}^{G}$	is the overall or grand mean.

Finally, as Berenson and Levine (1996) report, *within-group* variation measures ". . . the difference between each observation and the mean of its own group and cumulates the squares of these differences over all groups," (p.530). Within-group variation (SSW) is commonly referred to as experimental error. Its specific calculation is as follows:

$$SSW = \sum_{j=1}^{c} \sum_{i=1}^{n_j} (X_{ij} - \bar{X}_j)^2 \quad \textbf{(7)}$$

where X_{ij} is the ith observation in subgroup j,

$\bar{X}_j$ is the sample mean of subgroup j

From Berenson and Levine (1996), when each of these sums of squares is divided by its respective degrees of freedom, three variances or "mean square" values are formed: (1) mean square total (MST), (2) mean square among-groups (MSA), and (3) mean square within-groups (MSW). Each is expressed mathematically below.

$$\text{MST} = \frac{\text{SST}}{\text{n - 1}} \quad \textbf{(8)}$$

$$\text{MSA} = \frac{\text{SSA}}{\text{c - 1}} \quad \textbf{(9)}$$

$$\text{MSW} = \frac{\text{SSW}}{\text{n - c}} \quad \textbf{(10)}$$

An F statistic is calculated by taking the ratio of MSA to MSW, as seen below in Equation 11.

$$\text{F} = \frac{\text{MSA}}{\text{MSW}} \quad \textbf{(11)}$$

This F statistic is of interest to interpret the results of ANOVA. As indicated by Berenson and Levine (1996), this F statistic exhibits an F distribution with c - 1 and n - c degrees of freedom. At a specific level of significance, the null hypothesis stated in Equation 3 is rejected and the calculated costs of production between study groups are determined to be significantly different, if the calculated F statistic of Equation 3 is greater than the critical F value. Parallel to this, the null hypothesis is not rejected and the operating expenditures of study groups are not considered significantly different from each other if the computed F statistic is less than the critical F value.

> If the null hypothesis were true, we should expect the computed F statistic to be approximately equal to 1, since both the numerator and denominator mean square terms are estimating the true variance. . . . if H_0 is false (and there are real differences in the means), we should expect the computed F statistic to be substantially larger than 1 because the numerator, MSA, would be estimating the treatment effect or differences among groups in addition to the inherent variability in the data, whereas the denominator, MSW, would be measuring only the inherent variability (Berenson and Levine, 1996; p.531).

Berenson and Levine (1996, Chapter 14) provide a more in-depth discussion on the empirical development of an ANOVA analysis.

To justify the use of an ANOVA analysis, three major assumptions must be made. First, it is assumed that the population data are randomly chosen for the analysis and as a result independence of errors exists. Second, it is assumed that normality prevails among the values of subgroups. More specifically, it is assumed that calculated costs of production are normally distributed within each subgroup of herd size and milk yield. The third and final assumption made when performing an ANOVA is the homogeneity of variance. According to Berenson and Levine (1996), "... homogeneity of variance states that the variance within each population should be equal for all populations . . . this assumption is needed in order to combine or pool the variances within the groups into a single with-in group source of variation," (p.539). It is therefore assumed that the variance of each category of herd size and milk yield do not differ from one another.

5.1.3 Technical and Economic Efficiency

Following Jeffrey (1992) and Phillips et al (1989), technical and economic efficiency measures for the various study groups are computed using a farm management approach. A farm's physical efficiency can be described by its milk productivity and labour productivity. In this thesis, milk productivity is measured by the average hectolitres of milk produced per cow on each farm. Labour productivity is expressed in terms of cows per worker equivalent. Jeffrey (1992) defines a worker equivalent as ". . . the annual number of labour hours available from a full-time worker (operator or employee)," (p.6). This study denotes one worker equivalent as 2,500 hours of labour in the annual period.

Complying with the format of Jeffrey (1992), economic efficiency is measured in terms of cost efficiency and this is estimated by means of cost control ratios. According to Jeffrey (1992), cost control ratios demonstrate a farm's "... ability to convert input costs into dairy sales," (p.7). Ratios for feed, labour, and the total user cost of capital are derived as these represent three major categories of production expenses for dairy farms. A cost control ratio for the total cost of production is also computed. As revealed by Jeffrey (1992), ratios are expressed in terms of costs per dollar of dairy enterprise revenue; thus, the lower the cost control ratio, the more efficient the farm. Differences in the cost control ratios for each study group are tested for significance by performing a single factor analysis of variance (ANOVA) using the computer software package *Microsoft Excel*. As was explained in Section 5.1.2 of this study, if a statistically significant difference is detected by an analysis of variance comparing all three categories of herd size, or all three categories of milk yield, three additional ANOVAs are performed in order to assess the basis of the significant difference.

5.1.4 Farm Profitability

The competitive position of Alberta's dairy enterprises, from a revenue standpoint, is assessed by comparing the estimated average economic profit among categories of herd size and categories of milk yield for the 1996, 1995, and 1994 dairy years. As explained in Section 5.1.2 of this study, the economic profit of a farm results when values for family and operator labour and owner's equity are subtracted, along with all other costs of production, from the gross revenue of the dairy enterprise. In imputing the economic profits of surveyed farms, it is assumed that the Canadian supply managed milk price is received by producers each year. It is important to note that the prices received under the supply management arrangements will vary slightly between dairy enterprises depending upon the values attached to the butterfat, protein, and other solids composition of farm milk under Multiple Component Pricing.

A single factor / one-way ANOVA using the computer software package *Microsoft Excel* is performed to test for the significance of differences in the estimated economic profit of study groups. As was discussed in Section 5.1.2 of this study, if a statistically significant difference is found by an analysis of variance comparing all three categories of herd size, or all three categories of milk yield, three additional ANOVA tests are performed in order to assess where the significant difference is derived.

A sensitivity analysis of farm economic profit is then conducted by substituting the 1996, 1995, and 1994 Canadian supply managed producer price with various international milk prices. This assessment is employed for two main reasons. First, because international COP data were not available to make a comparison with Alberta's operating expenditures, the substitution of a given international milk price may provide the best alternative to judge the relative cost competitive situation of dairy enterprises in the province. The second reason for adopting this method of analysis is to gain insight into possible potential effects of much lower milk prices on Alberta producers that might be caused by the removal of tariff rate quota controls. It is recognized that this is a simplified analysis of such a situation. The prices utilized in this thesis are not a representation of what Alberta dairy producers would actually receive in the event of international trade. Simulated prices are the current milk prices in the given region and are subject to change as import controls are dismantled. It also must be noted that the costs associated with transporting milk internationally are not factored into the stated prices.

Four different milk prices were chosen for substitution in this exercise. These prices were obtained from Dairy Farmers of Canada (1999). Selection was based on the respective nation's potential impact on Canada's dairy trade and domestic milk prices in the event of deregulation. The first and most obvious choice was to incorporate milk prices applicable to the United States due to its geographical proximity to Canada. Second, Mexico's national dairy price was used in a further simulation. The decision to include Mexican milk prices is justified on the fact that the North American Free Trade Agreement (NAFTA) is consolidating the North American trading environment in which Mexico is becoming a more prominent player. The third domestic price to be substituted in a comparison of costs of production in Alberta was that of New Zealand. There is a general consensus that New Zealand is a relatively low cost dairy producer. The fact that New Zealand has one of the lowest dairy COP justifies its inclusion in this sensitivity analysis of potential producer profitability.

One further comparative milk price is considered based on findings of Cox and Zhu (1997). By constructing a hedonic spatial equilibrium model of the world dairy sector, these two researchers concluded that with complete trade liberalization in the world dairy sector, the farm-gate price for milk in Canada would fall by 24 percent.[16] Thus, an estimate of a trade-liberalized Canadian milk price is calculated by decreasing the prevailing producer milk price by 24 percent. In each price simulation, federal milk subsidy payments and milk levies are subtracted from each farms' statement of income to allow the revenue of Alberta dairy farmers to reflect trade liberalization. It is assumed that Alberta dairy farmers are not compensated for the value of lost marketing quota.

After imputing the economic profits of surveyed farms at international milk prices, a correlation analysis was performed. More specifically, the coefficient of correlation between economic profit and select operational features and costs or production is calculated using the computer software package *Microsoft Excel*. A correlation analysis measures the strength of the association between two numerical variables. The possible value for a correlation coefficient ranges from -1 (exact negative relationship between variables) through 0 (no linear relationship between variables) to 1 (exact positive relationship between variables). Equation 12 reveals the formula for directly computing the correlation coefficient r as provided by Berenson and Levine (1996):

$$r = \frac{\sum_{i=1}^{n} (X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum_{i=1}^{n} (X_i - \bar{X})^2} \sqrt{\sum_{i=1}^{n} (Y_i - \bar{Y})^2}} \qquad \textbf{(12)}$$

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[16] Cox and Zhu (1997) report that their hedonic spatial equilibrium model was developed around twenty-five international milk producing regions and seven specific dairy commodities. The results are relative to 1989 to 1992 average levels of production, consumption, prices, and trade flows.

where

$$\sum_{i=1}^{n} (X_i - \bar{X})(Y_i - \bar{Y})$$ is the sum of squares,

$$\sqrt{\sum_{i=1}^{n} (X_i - \bar{X})^2} \sqrt{\sum_{i=1}^{n} (Y_i - \bar{Y})^2}$$ is the total sum of squares.

As when performing an ANOVA, the validity of results obtained from a correlation analysis is dependent upon the assumptions of independence of errors, normality, and homogeneity being met. However, a fourth assumption is imperative when deriving a coefficient of correlation: linearity. Specifically, the relationship between economic profit and operational features and costs of production must be linear.

5.2 THE DATA

5.2.1 Source

Cost of production data for selected Alberta dairy producers were utilized in this study. The observed data, obtained from the Production Economics Branch, Economic Services Division of Alberta Agriculture, Food and Rural Development, were primarily compiled to construct the province's annual dairy cost study.[17] Figures are tabulated from monthly questionnaires completed by all participating dairy producers. According to Appleby (1995), the monthly survey data are collected to represent a cross section of Alberta's dairy farms according to the size of their fluid milk quota. Appleby (1995) explains that producers are divided regionally, northern versus southern Alberta, and are then ranked from largest to smallest, corresponding to their quota holding.[18] Systematic random sampling is carried out to select the participating farms for the study.[19] Appleby (1995) contends that because the quality and the cost of producing industrial milk are not significantly different than for fluid milk, and since approximately one-half of fluid milk produced in the province is used for industrial milk manufacturing, basing data collection entirely on a farm's fluid quota should not compromise the analysis. It is stressed that the COP data employed encompasses only those costs incurred by the participating farms' dairy enterprise. Appleby (1995) defines the dairy enterprise as "... all activities associated with the milking cows, dry cows and young dairy stock," (p.3).

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[17] Alberta's annual dairy cost study was introduced during World War II and continues to be used today as a component in setting fluid milk prices.

[18] According to Appleby (1994), the Production Economics Branch identifies the region north of the 39th township as 'northern Alberta' and the region lying south of the 39th township is recognized as 'southern Alberta'.

[19] According to Appleby (1995), the sample size is determined statistically according to the following equation: $n = \frac{4 \times s^2}{L^2}$

5.2.2 Defining Revenue and Cost Data

As previously stated, the validity of any COP study is dependent upon the careful definition of each source of revenue and each cost component. The following sections outline the interpretation of revenue and production cost sources which were contained in the data set employed by this thesis to assess the cost competitiveness of Alberta dairy farms.

5.2.2.1 Milk Sales

As only the dairy enterprise of each farm is examined, milk sales are the primary source of revenue. The producer price for fluid milk is set by the Alberta Energy and Utilities Board (AEUB) and administered by the Alberta Dairy Control Board (ADCB). Like the federally determined target price for industrial milk, the AEUB uses a formula reflecting particular items that influence the cost of milk production. The AEUB alters the fluid milk price only when a trend persists two to three months is observed in the price suggested by the formula. Table 5.1 outlines changes in the province's producer price for fluid milk that occurred during the time period of study, from 1994 to 1996.

5.2.2.2 Producer Subsidy

The federal dairy subsidy directly paid to dairy farmers was $1.508 per kilogram of butterfat or $5.43 per hectolitre of milk produced per farm in 1994. At the beginning of the 1995 dairy year, the direct producer subsidy payment was decreased to $1.28 per kilogram of butterfat or $4.62 per hectolitre of milk. The subsidy was further reduced in 1996 by $0.82 per hectolitre, over the previous year to a level of $3.80 per hectolitre of milk produced (Canadian Dairy Commission, 2000.h).

5.2.2.3 Milk Levies

According to Appleby (1995), an "all milk levy", administered by the CDC, was charged to producers during 1994 and 1995. This levy funded the removal of surplus skim milk powder from the Canadian market. All milk produced between January 1st and July 31st, 1994 was charged a levy of $0.25 per kilogram of butterfat. This levy increased to $0.49 per kilogram of butterfat August 1st, 1994 and was reduced to $0.25 per kilogram of butterfat on August 1st, 1995.

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where: n is sample size
s is the standard deviation of the population
L is the expected accuracy of the sample average cost

TABLE 5.1: Alberta Fluid Milk Price Changes: 1993 - 1996

EFFECTIVE DATE	PRODUCER PRICE ($/hL)	CHANGE ($/hL)
October 1, 1993	56.95	+ 0.98
May 1, 1994	55.97	- 0.98
March 1, 1995	56.95	+ 0.98
July 15, 1995	58.91	+ 1.96
January 1, 1996	60.87	+ 1.96
April 1, 1996	62.83	+ 1.96
July 15, 1996	64.79	+ 1.96

Source: Appleby (1994, 1995, 1996).

An over-quota levy on each kilogram of butterfat produced in excess of 100 percent of producer MSQ was also required in 1994 and 1995. This "producer tax" was used to fund the exportation of dairy products which exceeded domestic consumer demand (Appleby, 1995). The over-quota levy was set at $8.90 per kilogram of butterfat between January 1st and July 31st, 1994. On August 1st, 1994 this increased to $9.08 per kilogram of butterfat. From January 1st, 1995 to July 31st, 1995 producers were charged $9.06 per kilogram of butterfat on excess milk production. On August 1st of the same year, the over-quota levy was reduced to $7.77 per kilogram of butterfat (Appleby, 1995). With the implementation of the milk category termed the 'Special Milk Classes', and with the introduction of the Western Milk Pool, all levies charged to producers were eliminated.

5.2.2.4 ***Net Cattle Sales and Net Inventory Change***

As noted by Appleby (1995), due to the fact that the cost of raising young dairy stock is an expense incurred in the production of milk, net cattle sales and net inventory change should be included in enterprises' total income. Net cattle sales are equal to the balance of the dollar value of cattle purchased, subtracted from the dollar value of cattle sold. Each farm was required to report the sale and purchase prices of their cows, bred heifers, open heifers, heifer calves, bull calves and bulls.

Changes in a farm's herd composition or an operation's "herd growth" is determined by calculating the net inventory adjustment (Appleby, 1995). In this thesis study, the year-end inventory for each of the cows, bred heifers, open heifers, heifer calves, bull calves, and bulls was subtracted from the corresponding inventory at the beginning of the year for each category. The net inventory change for each year was calculated by summing the dollar value of each annual inventory change.

5.2.2.5 ***Miscellaneous Receipts***

Any revenue generated outside the sale of milk and cattle or apart from pool adjustments is represented by miscellaneous receipts. As this analysis only examines the dairy enterprise of each sampled dairy operation, miscellaneous receipts consist only of the sale of assets specific to the production of milk. Examples include the sale of pasture land, dairy buildings and equipment.

5.2.2.6 ***Farm Produced Feeds***

Farm produced feeds utilized by the dairy enterprise can be valued by one of two methods: (1) the whole farm approach or (2) the enterprise approach. According to Ross et al (1998), the CDC annual national milk cost of production study uses a whole farm approach in determining dairy feed costs. Farm produced feeds are valued at their cost of production less operator and family labour costs. Ross et al (1998) clarify that labour costs of cropping are included in the CDC calculations of total labour costs. Jeffrey (1992) identifies costs of seed, fertilizer, pesticides, real estate rental, machinery expenses and depreciation and any hired labour that is exclusive to the farm's cropping enterprise, as the costs of production incurred by those farms producing their own feed. Barichello and Stennes (1994) also employ a whole farm approach; they note that if farm-produced feed is sold and cannot be netted from total feed costs, revenues from the sale of the feed must be subtracted from total dairy costs.

This study follows the enterprise approach, as used by Ross et al (1998) in valuing home-grown grains and forages. Here, farm produced feeds are valued at average annual market prices and are treated as purchases by the farm's dairy enterprise from its cropping enterprise. Specifically, hay produced on the farm is valued at regional prices of stacked hay on the farm. The cost of feed grain are taken as the regional elevator prices provided by the Alberta Grain Commission. Thus, the final cost incurred by a farm for farm-produced feeds is equal to annual regional commodity prices multiplied by the quantity consumed by the dairy enterprise.

5.2.2.7 Hired Labour

A cost competitiveness study of Canadian dairy producers by Barichello and Stennes (1994) did not utilize the values of hired labour expenditures which were indicated on farm data surveys. They conclude that there is an inconsistency in labour expenditure data from different surveys. They also recognize the difficulty in quantifying non-cash income received by farm workers. Thus, Barichello and Stennes (1994) recommend valuing any labour, other than unpaid operator and family labour, at a standard hired labour wage rate for the given region.

The concerns expressed above are valid. However, the hired labour data used in this analysis were taken directly from farm surveys collected by the Production Economics Branch. The inconsistencies in labour expenditure data noted by Barichello and Stennes (1994) are avoided as the same survey format is distributed to participating farms in each of the three observed years; 1994, 1995, and 1996. Along with the wage rate paid per worker on each farm, producers are required to record the value of any room and board provided to their employees.

5.2.2.8 Operator and Family Labour

The majority of dairy farms in Alberta are operated as family enterprises where family members contribute to the business through unpaid family labour. Because the dairy operation benefits from this investment, unpaid family labour can be calculated and recognized as a cost of production. As noted in Section 5.1.2 of this study, the approach used to handle unpaid family labour within a cost analysis defines the approach employed to evaluate the economic well-being of a farm enterprise. Because the economic costs and economic profit of the surveyed dairy operations are estimated, a dollar value for unpaid family and operator labour must be imputed.

The data utilized to impute the dollar value of family and operator labour were obtained from monthly labour statements recorded by individual farms. Total labour of the farm operator is valued at the annual Alberta farm management wage rates as reported by Statistics Canada.[20] Annual general farm labour wage rates for Alberta, also reported by

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[20] Annual farm management wage rates for Alberta, as reported by Statistics Canada

Statistics Canada, are assigned to hours worked by spouses and children of the farm operators.[21]

5.2.2.9 *User Cost of Capital*

As previously stated, the economic profit of producing milk at the farm level in Alberta is derived in this study. Therefore, a user cost of farm capital is imputed for each farm in the sample. This approach differs from the traditional method of determining accounting costs where the depreciation of farm capital is calculated and a farm's interest payment on its capital loan is computed. Estimating the user cost of capital provides an estimate of the *opportunity cost* of investing in the dairy industry rather than simply examining the farms' debt-load; thus, a more accurate picture of a farm's total costs can be portrayed.

This thesis study calculated the user cost of four capital assets comprising the dairy enterprise: (1) farm buildings, (2) farm machinery and equipment, (3) land, and (4) the dairy cattle. Consistent with Moschini (1988), the following equation was employed to derive each estimate of the user cost of capital for all farms in each set of annual data:

$$r_j = R_j \, (i + \delta_j) \tag{13}$$

where r_j is the user cost of capital input j,

R is the capital (replacement) price,
i is the interest rate or the opportunity cost of holding capital, and

δ_j is the physical depreciation rate.

In his empirical study of the cost structure of Ontario dairy farms, Moschini (1988) incorporated the tax rate charged to farm land and buildings and the expected capital gain of examined assets into the user cost of capital equation. In this study, tax payments incurred by individual dairy operations are included with farm insurance expenses in a separate cost

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CANSIM Matrix 160, are as follows: 1994 - $11.58 per hour; 1995 - $13.49 per hour; 1996 - $14.20 per hour.

[21] Annual general farm labour wage rates for Alberta, as reported by Statistics Canada CANSIM Matrix 160, are as follows: 1994- $9.53 per hour; 1995 - $9.06 per hour; 1996 - $9.34 per hour.

of production category. Capital gain of observed assets is assumed to be zero as this thesis examines a short-run time period.

The capital or replacement price R, expressed in Equation 13, is represented by the current value of each capital asset. Specifically, as stated by Appleby (1996), the current market value of the farms' capital assets is determined by updating their original value with corresponding inflation factors and then depreciating according to the number of years in use.

As defined by Brigham and Gapenski (1991), the interest rate, i, denotes the farm's opportunity cost of investing in the dairy industry or the rate of return the farm could earn on alternative investments of equal risk. When choosing the appropriate interest rate to represent a farm's opportunity cost, this must directly reflect levels of risk characteristic to the specific agricultural commodity. Bauer (1988) expands on this: "(the) degree of risk is frequently expressed in terms of how predictable a particular outcome is. Outcomes which deviate only a small amount from the expected or average value are said to be less risky than those which exhibit greater variability," (p.7). Statistically, risk is expressed as the standard deviation of a farm's percent return on its assets over time. Bauer (1988) reports that indices of returns on investments in stock markets are readily available, but are lacking in agriculture since formal trading of shares in farm businesses does not occur. However, an estimate of the business risk measure for a Quebec dairy farm, or the standard deviation of its percent return, is 0.18. This compares to a risk rating of 0.54 for a small Saskatchewan grain and oilseed farm and a risk measure of 1.37 for a Manitoba hog farrow to finish operation. Expanding on this, the risk premium of a hog farm is assessed as 10 to 20 percent, reflecting an opportunity cost interest rate of 15 to 25 percent. Since dairy farming exhibits a lower business risk than hog farming, an interest rate of 8 to 10 percent seems likely to reflect sufficiently the opportunity cost of an Alberta dairy enterprise.[22]

Interest rates for Government of Canada long term benchmark bonds were employed to represent the opportunity cost of farmers investing in the Alberta dairy industry. Interest rates for 1996, 1995 and 1994 were obtained by taking the average of the long term benchmark bond recorded for each month as reported by the Bank of Canada (2000). Interest rates of 7.75 percent, 8.41 percent, and 8.69 percent were utilized for 1996, 1995, and 1994 respectively.

The physical depreciation rates of capital employed in this study follow Moschini (1988). Farm machinery and equipment were depreciated at a rate of 0.15 while depreciation of farm buildings was calculated using a rate of 0.05. Land was not depreciated as this is a nondepreciable asset. For the dairy herd, like land, a depreciation rate of zero is assumed. Although individual dairy cows depreciate in value, because of the costing of herd replacement, the total value of the total dairy herd is maintained in the short run.

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[22] The discussion related to the unit cost of capital, and references to specific risk measures and opportunity costs for agricultural enterprises, is based on personal communication with Dr. Jim Unterschultz. 2000. Edmonton, Alberta.

5.2.2.10 Variable Costs versus Fixed Costs

All operating expenses incurred by a farm are classified to be either variable costs or fixed costs. Variable costs are those expenses that are responsive to changes in production levels while fixed costs remain constant as output varies in the short run. Stanton (1986) views variable costs as the most critical of all costs when conducting any cost comparison:

> In the longer run it is the differences in variable costs per unit of output which are most important in making comparisons. This is true because the fixed resources generally take on the value of expected future earnings from a profitable enterprise. The pricing of variable inputs are determined by current economic conditions and only need adjustments when they are directly affected by government action or subsidy (p.22).

Barichello and Stennes (1994) state that with the exception of hired labour, variable costs can be derived directly from survey data.

Fixed costs are comprised of cash and noncash items. Barichello and Stennes (1994) report that the cash portion of fixed costs are assessable directly from survey data and include costs of utilities, taxes, insurance and general overhead costs. The authors define noncash fixed costs as the rental cost for owned land, unpaid operator and family labour and theuser cost of farm capital stock (with the exception of production quota). According to Stanton (1986), the trend in the specialization of farm production allows more ease to access fixed cost accounting data.

The variable costs estimated in this thesis for sampled dairy farms include the following: feed; processing costs; bedding and supplies; breeding; veterinary and medicine costs; milk hauling; producer fees; utilities; fuel, oil, and lube; rent; labour expenses; and miscellaneous costs. The cash portion of imputed fixed costs are represented by taxes and insurance expenses, and building and machinery repairs. The noncash fixed cost estimated by this thesis is the user cost of capital. Table 5.2 defines how each variable and fixed expense was calculated for this thesis.

Levies incurred are factored into the gross revenue of each dairy enterprise, along with milk sales, subsidies, net cattle sales, and miscellaneous receipts. Producer marketing quota is not an estimated expense. It is argued that dairy quota is not a cost a production, rather it provides producers with the right to produce milk within Canada's supply managed dairy industry.

TABLE 5.2: Definition of Estimated Variable and Fixed Expenses

PRODUCTION EXPENSE	DEFINITION OF EXPENSE
VARIABLE EXPENSES	
Feed	*Purchased* dairy ration, calf feed, milk replacer, supplement, alfalfa pellets, molasses, minerals and vitamins, salt, brewers grain, beet pulp, oats, barley, wheat, mixed grain, alfalfa hay, straw fed, greenfeed and silage. *Farm Produced* oats, barley, wheat, mixed grain, alfalfa hay, straw feed, greenfeed and silage.
Processing Costs	Grinding and processing costs of home grown dairy feed.
Bedding and Supplies	Bedding and dairy supplies for cows, heifers and calves.
Breeding	Cow, heifer and other breeding costs.
Veterinary and Medicine	Veterinary care and medicine for cows, heifers and calves.
Milk Hauling	Milk transportation costs.
Producer's Fees	License and provincial milk producer association fees.
Utilities	Electrical and hydro costs.
Fuel, Oil and Lube	Fuel, oil, lube for operation of dairy buildings, machinery and equipment.
Rent	Charge on all rented resources.
Hired Labour	Hired farm labour.
Operator Labour	Dollar value of farm operator's labour contribution to dairy enterprise.
Family Labour	Dollar value of unpaid family labour.
Miscellaneous	Any other variable expense incurred by dairy enterprise.
FIXED EXPENSES	
Taxes and Insurance	Government taxes and farm insurance.
Building and Machine Repairs	Repair costs of dairy buildings and machinery.
User Cost of Capital	Opportunity cost of investing in dairy industry. User cost calculated for farm buildings, farm machinery and equipment, land and the dairy herd.

CHAPTER 6: RESULTS and DISCUSSION

6.1 CHARACTERISTICS OF STUDY GROUPS

As previously explained in Section 5.1.1 of this study, three distinct groupings of farm herd sizes were displayed when the distribution of the total number of milking cows per farm for 1994, 1995, and 1996 was mapped onto a histogram. The first cluster was found at 40 to 50 milking cows and is representative of Alberta's smaller dairy operations (Group H1). A second concentration of farm herd size data was found at 50 to 70 head of milking cattle. This subgroup is identified as Group H2 and is a proxy for the average sized dairy farms in the province. The third accumulation of farm herd size data was found at 90 milking head and above. This final grouping is a representation of Alberta's larger dairy enterprises and is referred to as Group H3.

The distribution of milk production per cow (average hectolitres of milk produced per cow per farm) for 1994, 1995, and 1996 was determined to be symmetrical. This meant that an adhoc grouping of farm data according to milk yield per cow was acceptable. To correspond with the three study groups of herd size, three divisions of milk yield were established. The first study group of milk yield, Group M1, is comprised of all farms realizing an average production per cow less than 80 hectolitres of milk. Group M1 is thus representative of Alberta's low yielding farms. The province's average dairy operation is depicted by Group M2, those surveyed farms with an average milk yield between 80 and 90 hectolitres per cow. High producing herds are all those farms achieving an average milk yield greater than 90 hectolitres per cow, Group M3.

The examination of characteristics and general operational features of study groups facilitates a greater understanding of farm level competitiveness. Identification of significant differences in the operating environment of each subgroup of herd size and milk yield provides a possible explanation for statistically different costs of production, efficiency, and profitability.

6.1.1 General Characteristics of Herd Size Groups: 1996 - 1994

The management and operational characteristics of the subgroups of dairy enterprises for which data are available are provided below according to farm herd size. The computed F statistic from the ANOVA for each group characteristic is also presented, indicating whether the data characteristics that are examined and assessed differ significantly between each study group. If a significant difference was found, three additional analyses of variance were conducted among the categories of herd size in order to identify the source of the variance. Tables 6.1, 6.2 and 6.3 summarize results for 1996, 1995 and 1994, respectively. Appendix B provides a statistical summary for the analysis of variance tests .

Since herd size is the defining factor of each study group, it is expected that there is a significant difference in the average number of milking cows in each defined group for each of the three consecutive years under examination. For small dairy herds (Group H1) the average herd size was 44.23 cows, 46.03 cows, and 45.64 cows in 1996, 1995, and 1994,

TABLE 6.1: 1996 Farm Characteristics of Three Study Groups Based on Herd Size[a]

FARM CHARACTERISTIC	GROUP H1 40-50 Dairy Cows	GROUP H2 50-70 Dairy Cows	GROUP H3 Over 90 Dairy Cows	F STATISTIC
Percentage of Study Farms	23.40	46.81	29.79	N/A
Average Milking Herd Size	44.23 cows	59.20 cows	130.39 cows	124.66*
Average Number of Years Farming	13.36	14.73	20.86	2.05
Average Dairy Income as percent of Total Farm Income per Farm	90.45	94.64	78.21	4.35*
Average Annual Milk Production (hl)	3,755.35	5,242.16	10,787.14	89.86*
Average Volume of Milk per Cow (hl)	84.85	88.30	82.04	1.56
Average Quota Holding per Farm (hl)	2,659.16	3,266.44	7,562.84	39.74*
Average Percent Over-Quota Milk Production	28.77	37.06	30.30	1.24
Average Quota Holding per Farm ($)	155,665.89	189,420.93	436,850.53	38.37*

a * denotes statistical significance at a 95 percent confidence interval

TABLE 6.2: 1995 Farm Characteristics of Three Study Groups Based on Herd Size[a]

FARM CHARACTERISTIC	GROUP H1 40-50 Dairy Cows	GROUP H2 50-70 Dairy Cows	GROUP H3 Over 90 Dairy Cows	F STATISTIC
Percentage of Study Farms	29.17	41.67	29.17	N/A
Average Milking Herd Size	46.03 cows	60.57 cows	136.84 cows	152.02*
Average Number of Years Farming	13.21	15.15	18.29	0.79
Average Dairy Income as percent of Total Farm Income per Farm	N/A[23]	N/A	N/A	N/A
Average Annual Milk Production (hl)	3,793.12	5,75.03	11,166.69	120.38*
Average Volume of Milk per Cow (hl)	82.04	83.89	82.46	0.12
Average Quota Holding per Farm (hl)	2,408.75	3,247.16	7,546.58	35.67*
Average Percent Over-Quota Milk Production	34.74	35.69	33.03	0.08
Average Quota Holding per Farm ($)	132,609.47	178,205.66	409,505.29	35.08*

a * denotes statistical significance at a 95 percent confidence interval

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[23] Recall that data reporting dairy income as a percent of total farm income was only available for the 1996 dairy year.

TABLE 6.3: 1994 Farm Characteristics of Three Study Groups Based on Herd Size[a]

FARM CHARACTERISTIC	GROUP H1 40-50 Dairy Cows	GROUP H2 50-70 Dairy Cows	GROUP H3 Over 90 Dairy Cows	F STATISTIC
Percentage of Study Farms	29.41	45.10	25.49	N/A
Average Milking Herd Size	45.64 cows	58.34 cows	135.02 cows	192.31*
Average Number of Years Farming	16.07	15.22	17.00	0.12
Average Dairy Income as percent of Total Farm Income per Farm	N/A	N/A	N/A	N/A
Average Annual Milk Production (hl)	3,514.50	4,935.39	11,080.03	160.85*
Average Volume of Milk per Cow (hl)	82.46	84.48	82.87	2.16
Average Quota Holding per Farm (hl)	2,498.70	3,020.32	7,582.87	41.08*
Average Percent Over-Quota Milk Production	27.69	37.90	31.90	1.31
Average Quota Holding per Farm ($)	136,105.97	162,425.20	405,373.24	39.46*

a * denotes statistical significance at a 95 percent confidence interval

respectively. The mean herd size for Alberta's average sized dairy operations (Group H2) was 59.20 cows in 1996, 60.57 cows in 1995 and 58.34 cows in 1994. The province's largest dairy farms, (Group H3) exhibited an average herd size of 130.39 cows in 1996, 136.84 cows in 1995 and 135.02 cows in 1994. An ANOVA analysis of annual milk production and farm quota holding, expressed in hectolitres and dollars, also denoted a difference in variance between the subgroups of herd sizes for each observed year. Further explanation is provided below.

Average annual milk production per farm was found to differ significantly between each individual study group for each of the three dairy years. As larger herd sizes imply greater volumes of milk produced, it is no surprise that a direct relationship between average annual milk production and herd size was observed. The small dairy farms examined, those milking between 40 and 50 cows, realized an average annual milk production of 3,755.35 hectolitres in 1996, 3,793.12 hectolitres in 1995 and 3,514.50 hectoltres in 1994. Average sized operations, farms comprised of 50 to 70 dairy cows, produced on average 5,242.16 hectolitres, 5,075.76 hectolitres and 4,935.39 hectolitres in 1996, 1995 and 1994, respectively. Average annual milk production for farms milking over 90 head was found to be 10,787.14 hectolitres in 1996, 11,166.69 hectolitres in 1995 and 11,080.03 hectolitres in 1994. Due to the fact that the average milk yield per cow did not differ significantly between groups, the inverse relationship observed with respect to average annual milk production and study group is solely the result of farm size; that is, the total number of milking cows per farm.

Parallel with annual milk production, average quota holding, expressed in terms of hectolitres per farm, increased with herd size. During 1996 and 1994, the large dairy herd group reported a significantly larger quota holding. In the 1995 dairy year, in was found that the average hectolitres of quota per farm differed significantly for each study group.

Recall from Section 2.2.4 of this study that the dollar value of quota is defined on a per hectolitre basis. The significance of differences in average quota holdings per farm, in terms of dollars, therefore mimics that of the average quota holding expressed in hectolitres. In 1996 and 1994, farms milking over 90 head were found to have a significantly larger quota value compared to those milking between 40 and 70 cows. During 1995, the average dollar value of quota per farm differed significantly between all three study groups.

As was previously noted, data revealing dairy income as a percent of total farm income were available only for 1996. An ANOVA analysis revealed that a significant difference in dairy income (expressed as a percentage of total farm income) existed between farms comprised of 50 to 70 milking cows (Group H2), and farms milking over 90 head (Group H3). Specifically, for Group H2 the dairy enterprise accounted for 94.64 percent of total farm income while milk production comprised only 78.21 percent of net returns for farms in Group H3. The fact that the largest dairy operations in the sample reported the smallest portion of their net farm income to arise from the production of milk was surprising and interesting.

It is generally believed that larger sized herds are more difficult to manage than small herds due to the need for increased time and skills. This, in turn, might be expected to encourage more intensive and specialized larger operations. However, because the dairy enterprise becomes a less important source of income for Alberta dairy farms milking over 90 head, it can be suggested that the managers of larger dairy farms in Alberta are more diversified in their business ventures. Recognizing that Alberta's large-scale dairy farms are diversified operations spurs consideration of factors influencing the management decisions of producers.

As noted in the review of literature (Section 3.2), Houck (1992) contends that specialization is a main catalyst for absolute free trade: "specialization according to comparative advantage permits a nation to produce more export goods than it wants, then trade them for less costly imported goods from all over the world," (p.16). The fact that the province's largest dairy herds are broadening their business ventures might suggest that the *perceived* comparative advantage of farm managers does not lie in milk production. Perhaps dairy producers lack confidence in the current direction of Canada's supply management system, or maybe the high cost of marketing quota has created a barrier to further growth of some dairy farmers, preventing the further expansion of their dairy herds; thus inhibiting the province of Alberta from realizing a comparative advantage in milk production. Another possible explanation is that Alberta's largest dairy producers may be pursuing particular vertical or horizontal integration linkages or activities. Unfortunately, because the examined data set presents cost figures incurred by the dairy enterprise only, it is impossible to conclude whether any of these speculations is applicable. The questions raised suggest that further research examine the nature of apparent diversification for Alberta's large-scale dairy operations.

From the literature review (Section 4.4), Barichello et al (1996) report that many studies on the competitiveness of Canada's dairy industry conclude average yield per cow to increase with herd size: "this suggests that lower COP result not merely from an increase in farm size but also from an increase in yield per cow or a combination of these two factors," (p.108). It may be noted that the data compiled for this study do not support this inference about the relationship between herd size and milk yield. In each of the three years of observed data, average milk production per cow did not differ significantly between the subgroups of herd size. This statement made by Barichello et al (1996) will be re-examined in further analyses within this thesis.

6.1.2 General Characteristics of Milk Yield Groups: 1996 - 1994

Characteristics revealing the management and operational features of the subgroups of farm milk yield are provided below. The computed F statistic from the ANOVA for each group characteristic is also presented, indicating whether the data characteristics that are examined and assessed differ significantly between each category of milk yield. If a significant difference was found, three additional analyses of variance were conducted among the study groups in order to identify the source of the variance. Results for 1996, 1995 and 1994 are found in Tables 6.4, 6.5 and 6.6 respectively. Refer to Appendix C for a statistical summary of the analysis of variance performed.

Tables 6.4, 6.5, and 6.6 show that the percentage of surveyed farms categorized according to milk yield are fairly evenly distributed between study groups. This uniform allocation of farms reflects the normal distribution of milk production per cow identified by the histogram of milk yield per cow. As milk production per cow is the defining characteristic of each of these subgroups of farms, a significant difference in milk yield between study groups was found in all three years examined. Low producing herds (Group M1) realized an average production per cow figure of 73.52 hectolitres, 70.69 hectolitres and 71.82 hectolitres in 1996, 1995 and 1994, respectively. Group M2 achieved an average milk yield of 85.15 hectolitres per cow in 1996, 85.90 hectolitres per cow in 1995, and 85.77 hectolitres per cow in 1994. High yielding farms (Group M3) were found to have an average production level of 95.57 hectolitres per cow in 1996, 96.33 hectolitres per cow in 1995, and 96.38 hectolitres in 1994.

During the 1996 and the 1994 dairy years, the percentage of over-quota milk production was found to be significantly different between farm subgroups. In 1996, at 43.40 percent, farms with an average milk yield greater than 90 hectolitres per cow (Group M3) reported a significantly higher quantity of over-quota milk production compared to farms averaging less than 90 hectolitres of milk per cow. In 1994 a significant difference in over-quota milk production was detected between study groups M1 and M3: 28.87 percent versus 30.02 percent.

The average number of years that dairy operators have been farming was not significantly different between the groups' farms that were separated according to milk yield, except in 1994. Specifically, at an average of 10.55 years, farms with an average milk yield between 80 and 90 hectolitres per cow were managed by operators who had been involved in the industry for a significantly less number of years. Herds comprising Groups M1 and M3 were operated by individuals who had been farming for an average of 19.10 years and 17.62 years respectively. Because no significant difference in the number of years farming applied between groups for the 1996 and 1995 data, it is concluded that 1995 surveyed farms which averaged between 80 and 90 hectolitres of milk per cow (Group M2) involved a younger sample of farmers than those operating farms with an average milk yield less than 80 (Group M1) or herds with an average production level greater than 90 hectolitres per cow (Group M3).

No evidence of a statistically significant trend in herd size with respect to milk production was found over the three years examined. This finding does not support the inference made by Barichello et al (1996) that average yield per cow increases with herd size. Again, the relationship between herd size and milk yield will be addressed in later analyses within this thesis.

Statistically significant differences in the management characteristics and general operational features of study groups identified above facilitates a greater understanding of farm level competitiveness. The issues arising from the above discussion will be incorporated into the preceding analyses of this thesis. Reasoning for significant differences in the operating environment of each subgroup of herd size and milk yield could possibly provide an explanation for contrasting costs of production estimated in Section 6.2, for different levels of efficiency derived in Section 6.3, and for varying measures of profitability imputed in Section 6.4.

TABLE 6.4: 1996 Farm Characteristics of Three Study Groups Based on Milk Yield[a]

FARM CHARACTERISTIC	GROUP M1 Under 80 hl/cow	GROUP M2 80-90 hl/cow	GROUP M3 Over 90 hl/cow	F STATISTIC
Percentage of Study Farms	31.15	36.07	32.79	N/A
Average Milk Yield (hl/cow)	73.52	85.15	95.57	98.57*
Average Number of Years Farming	17.05	15.05	16.15	0.19
Average Dairy Income as percent of Total Farm Income per Farm	87.58	84.64	92.60	0.99
Average Annual Milk Production (hl)	5,283.38	6,200.02	6,654.33	0.99
Average Herd Size	71.80 cows	72.69 cows	69.96 cows	0.03
Average Quota Holding per Farm (hl)	3,705.28	4,603.02	3,826.91	0.80
Average Percent Over-Quota Milk Production	27.38	28.39	43.40	7.37*
Average Quota Holding per Farm ($)	217,887.08	265,767.25	220,741.49	0.73

a * denotes statistical significance at a 95 percent confidence interval

TABLE 6.5: 1995 Farm Characteristics of Three Study Groups Based on Milk Yield[a]

FARM CHARACTERISTIC	GROUP M1 Under 80 hl/cow	GROUP M2 80-90 hl/cow	GROUP M3 Over 90 hl/cow	F STATISTIC
Percentage of Study Farms	35.82	41.79	22.39	N/A
Average Milk Yield (hl/cow)	70.69	85.90	96.33	165.13*
Average Number of Years Farming	16.25	14.89	18.33	0.53
Average Dairy Income as percent of Total Farm Income per Farm	N/A	N/A	N/A	N/A
Average Annual Milk Production (hl)	5,170.74	6,374.71	6,086.74	0.99
Average Herd Size	73.87 cows	73.88 cows	62.94 cows	0.47
Average Quota Holding per Farm (hl)	3,411.57	4,404.89	3,776.82	1.05
Average Percent Over-Quota Milk Production	29.59	32.41	40.07	1.74
Average Quota Holding per Farm ($)	188,839.69	239,196.27	205,505.30	0.93

[a] * denotes statistical significance at a 95 percent confidence interval

TABLE 6.6: 1994 Farm Characteristics of Three Study Groups Based on Milk Yield[a]

FARM CHARACTERISTIC	GROUP M1 Under 80 hl/cow	GROUP M2 80-90 hl/cow	GROUP M3 Over 90 hl/cow	F STATISTIC
Percentage of Study Farms	44.60	27.03	28.38	N/A
Average Milk Yield (hl/cow)	71.82	85.77	96.38	158.62*
Average Number of Years Farming	19.09	10.55	17.62	4.96*
Average Dairy Income as percent of Total Farm Income per Farm	N/A	N/A	N/A	N/A
Average Annual Milk Production (hl)	4,938.20	5,620.80	6,552.40	1.90
Average Herd Size	68.48 cows	65.13 cows	67.78 cows	0.05
Average Quota Holding per Farm (hl)	3,349.18	4,007.91	3,916.53	0.61
Average Percent Over-Quota Milk Production	28.87	30.02	41.41	3.47*
Average Quota Holding per Farm ($)	182,247.24	213,859.43	206,973.57	0.46

a * denotes statistical significance at a 95 percent confidence interval

6.2 COSTS OF PRODUCTION

The estimated economic costs of production for Alberta dairy farms are presented in Tables 6.7 to 6.12 for each of the three years examined: 1996, 1995, and 1994. The preceding discussion in Section 6.2.1 is related to the possibility that economies of size may apply in the province's dairy industry and was based on COP estimates for the observed data as farms are grouped by herd size. The following section (6.2.2) is directed at the possibility of whether economies of yield exist among Alberta dairy producers based on estimated production costs for the three study groups of farms grouped by differences in milk yield. All estimated costs are averages for the respective study groups and are reported in terms of dollars per hectolitres of milk produced ($/hectolitre).

6.2.1 Investigating Economies of size: Herd Size Distribution of Data

6.2.1.1 Estimated economic costs of production for the 1996 dairy year

1996 estimates of costs of production, calculated using the assumptions expressed in Chapter 5, for three groups based on differences in herd size, are reported in Table 6.7. An F statistic from the single factor / one-way ANOVA preformed for individual production expenses is also presented to indicate whether or not each estimated group average cost of production differs significantly between the three study groups. If a given cost was identified as being significantly different among the study groups, three additional analyses of variance were run to determine the source of the variation. Refer to Appendix D for the statistical summary of each ANOVA test conducted.

Total production costs derived from the 1996 data set were found to decrease as herd size is increased; however, total cost differences between the three study groups were not statistically significant. Thus, the existence of economies of size among Alberta dairy producers cannot be inferred for the 1996 total production cost data constructed as outlined in Chapter 5. However, although none of the specified groupings of herd size demonstrated a significant total cost advantage over other groupings, significant differences among study groups were observed for some operating expenses, as detailed below.

Fuel, oil and lube costs were found to differ significantly for small and average sized herds. For farms milking 40 to 50 head (Group H1) the reported average operating expense was $1.06 per hectolitre, while herds comprised of 50 to 70 milking cows (Group H2) reported an average production cost of $0.69 per hectolitre, a per unit cost advantage of $0.37 over the small herd size group. Recognizing that the user cost of farm capital did not differ significantly between study groups, it is concluded that farms milking over 50 head are more cost efficient users of fuel, oil and lube in their operation of dairy buildings, machinery and equipment.

Miscellaneous expenses were found to differ significantly between Group H2 and Group H3. More specifically, a $1.21 per unit decrease was calculated as miscellaneous costs fell from $2.23 per hectolitre to $1.02 per hectolitre, when moving from the group of farms milking 50 to 70 head to the large herd size grouping of farms milking over 90 head.

TABLE 6.7: 1996 Average Dairy Costs of Production by Cost Category According to Herd Size ($/hl)[a]

COST ITEM	GROUP H1 40 - 50 Dairy Cows	GROUP H2 50 - 70 Dairy Cows	GROUP H3 Over 90 Dairy Cows	F STATISTIC
Feed	20.35	18.84	19.96	0.84
Processing	0.23	0.18	0.03	2.07
Bedding & Supplies	1.74	2.04	1.54	3.15
Breeding	0.74	0.81	0.66	0.56
Vet & Medicine	1.37	1.52	1.23	0.56
Milk Hauling	1.84	1.78	1.77	0.69
Producer Fees	1.03	1.00	1.01	2.75
Utilities	1.19	1.09	1.23	0.56
Fuel, Oil & Lube	1.06	0.69	0.53	6.14*
Rent	1.23	0.51	0.32	2.13
Miscellaneous Expenses	1.33	2.23	1.02	3.49*
Hired Labour	0.44	1.95	4.73	21.70*
Unpaid Family Labour	3.06	2.58	1.33	3.12
Operator Labour	8.71	6.78	2.39	33.59*
Insurance & Tax	0.59	0.73	0.67	0.49
Build/Machine Repairs	1.68	2.06	2.14	1.01
User Cost of Buildings	4.18	4.50	4.88	0.22
User Cost of Machinery & Equipment	3.18	3.17	3.05	0.04
User Cost of Land	0.50	0.53	0.25	2.95
User Cost of Dairy Herd	1.76	1.85	1.89	1.47
Total Variable Cost[b]	**32.12**	**30.66**	**29.29**	**1.61**
Total Labour Cost	**12.20**	**11.30**	**8.45**	**9.76***
TOTAL COP	56.22	54.80	50.62	2.75

a * denotes statistical significance at a 95 percent confidence interval

b Average Total Variable Cost excludes labour expenses

Hired labour expenses differed significantly between each study group, revealing a direct relationship between COP estimates and categories of herd size. For Group H1, farms milking 40 to 50 cows, an average hired labour cost of $0.44 per hectolitre of milk was calculated. Group H2, comprised of farms with 50 to 70 milking head, reported a hired labour expense averaging $1.95 per hectolitre of milk produced. Farms milking over 90 cows, Group H3, reported the greatest average hired labour expense for 1996 at $4.73 per hectolitre.

In contrast to hired labour expenses, imputed operator labour costs were found to decrease as herd size increased. The small herd size grouping incurred an average imputed operator labour cost of $8.71 per hectolitre. Average sized dairy operations reported an average operator labour expense of $6.78 per hectolitre, while the operator labour cost estimated for large herd size groups was $2.39 per hectolitre. It is concluded that as herd size is increased, hired labour is substituted for operator labour. This trend in farm labour composition is found to be cost effective, because the lower imputed operator labour for farms milking over 90 head outweighed the cost of hired labour for farms milking under 70 head. Specifically, at $8.45 per hectolitre, the large herd size group reported a significantly lower average total labour cost compared to the small and average herd size groups whose estimated average total labour expenses were $12.20 per hectolitre and $11.30 per hectolitre respectively.

***6.2.1.2** Estimated economic costs of production for the 1995 dairy year*

Table 6.8 outlines estimated 1995 producer costs of production for three groups based on differences in farm herd size. The F statistic from the single factor / one-way ANOVA performed for each production expense is reported. If a given cost was identified as being significantly different among the study groups, three additional analyses of variance were run to assess the source of the variation. A statistical summary of each analysis of variance is provided in Appendix D.

In 1995, as in 1996, an inverse relationship between average total costs of production and herd size was observed. However, in contrast to the 1996 cost estimates, total cost differences for the 1995 dairy year were found to be significantly different for the three groups. More specifically, total annual expenditures of the large herd size group differed significantly from those of the small and average sized herd groups. Thus, it is concluded that during 1995, cost benefits of larger size were achieved by Alberta dairy farms milking over 90 cows. Operations comprised of 40 to 50 milking cows (Group H1) reported the highest average total cost of milk production at $55.81 per hectolitre. For herds of 50 to 70 head (Group H2) an average total milk production expense of $55.38 per hectolitre was estimated. Farms milking over 90 head (Group H3) achieved the lowest average total milk COP value for 1995 at $45.59 per hectolitre; $10.22 a unit less than the average total milk production cost of Group H1, and $9.79 per hectolitre below the average total operating expense incurred by Group H2. Significantly lower use of both family labour and operator labour production costs, and a lower user cost of land outweighed a significantly higher utilities expenditure, allowing Group H3 to achieve this total cost advantage. This finding is discussed further below.

TABLE 6.8: 1995 Average Dairy Costs of Production by Cost Category According to Herd Size ($/hl)[a]

COST ITEM	GROUP H1 40 - 50 Dairy Cows	GROUP H2 50 - 70 Dairy Cows	GROUP H3 Over 90 Dairy Cows	F STATISTIC
Feed	16.19	16.38	16.66	0.14
Processing	0.07	0.14	0.10	0.27
Bedding & Supplies	1.60	1.69	1.54	0.29
Breeding	0.62	0.81	0.46	1.94
Vet & Medicine	1.02	1.26	1.06	1.08
Milk Hauling	1.85	1.78	1.77	2.17
Producer Fees	0.97	0.96	0.98	1.162
Utilities	0.97	0.95	1.20	3.28*
Fuel, Oil & Lube	0.72	0.60	0.49	1.57
Rent	0.45	0.19	0.27	0.77
Miscellaneous Expenses	1.36	1.80	1.78	0.44
Hired Labour	1.46	2.52	1.39	2.23
Unpaid Family Labour	6.03	4.83	2.11	24.75*
Operator Labour	8.83	6.90	2.56	24.61*
Insurance & Tax	0.91	0.80	0.57	2.65
Build/Machine Repairs	1.85	1.87	1.70	0.19
User Cost of Buildings	4.93	5.26	5.23	0.10
User Cost of Machinery &Equipment	3.09	3.92	3.36	1.51
User Cost of Land	0.73	0.61	0.26	6.05*
User Cost of Dairy Herd	2.14	2.12	2.10	0.26
Total Variable Cost[b]	**25.82**	**26.57**	**26.32**	**0.21**
Total Labour Cost	**16.32**	**14.24**	**6.05**	**23.97***
TOTAL COP	**55.81**	**55.38**	**45.59**	**9.47***

a * denotes statistical significance at a 95 percent confidence interval

b Average Total Variable Cost excludes labour expenses

The 1995 average family labour expense calculated for the large herd size group was $2.11 per hectolitre. This figure differed significantly from the small and average sized herd. Decreasing with herd size, average family labour costs for Groups H1 and H2 were $6.03 per hectolitre and $4.83 per hectolitre respectively.

Operator labour expenditures mimicked family labour costs as herds over 90 head (Group H3) reported a significantly lower average cost for this labour category at $2.56 per hectolitre. The smaller farms (Group H1) reported an average operator labour production cost of $8.83 per hectolitre while for average sized herds (Group H2), an expense of $6.90 per hectolitre applied.

The cost advantage in family labour and operator labour reported by the large herd size group allowed the farms milking over 90 head to achieve a significantly lower average total labour cost at $6.05 per hectolitre. The estimated average total labour cost for the small and average sized herd groups were $25.82 per hectolitre and $26.57 per hectolitre.

The user cost of land was found to be significantly lower for farms milking over 90 head compared to farms comprised of less than 90 milking cows. The computed 1995 average user cost of land was $0.26 per hectolitre for Group H3 while Groups H1 and H2 reported an average user cost of $0.73 and $0.61 per hectolitre, respectively. An ANOVA analysis performed to examine differences in the market value of land among farms in each study group (the value of R in Equation 31) found no significant difference in land values between the three groups. A second ANOVA analysis was conducted; this time the market value of farm land was measured on a per hectolitre basis. Results showed the value of land for the large herd size group to be significantly lower than that of the small and average sized herd groups. From these two findings it is inferred that the lower user cost of land achieved by farms milking over 90 cows is the result of economies of size rather than a reflection of factors influencing land prices, such as farm location and development potential.

In contrast to family and operator labour expenses and the user cost of land, the utilities expense incurred by Group H3 was significantly higher than the utilities component of production costs for Groups H1 and H2. Specifically, farms milking over 90 head reported an average utilities expense of $1.20 per hectolitre. Herds of 50 to 70 cows realized the lowest average utilities cost at $0.95 per hectolitre. Operations comprised of 40 to 50 head followed with an average utilities cost of production of $0.97 per hectolitre.

6.2.1.3 *Estimated economic costs of production for the 1994 dairy year*

Estimated farm-level costs of production for 1994, the final dairy year to be examined in this study, are presented below in Table 6.9 for the three groups of herd size. The F statistic from the single factor / one-way ANOVA performed for each production expense is indicated. If a given cost was identified as being significantly different among the study groups, three additional analyses of variance were run to assess the source of the variation. Refer to Appendix D for a statistical summary of each analysis of variance conducted.

For each of the three years considered, average total costs of milk production were found to decrease as herd size increased. Specifically, average total annual expenditures of the large herd size group differed significantly from those of the small and average sized herd groups. This mirrors the evidence found in the 1995 data set that economies of size

TABLE 6.9: 1994 Average Dairy Costs of Production by Cost Category According to Herd Size ($/hl)[a]

COST ITEM	GROUP H1 40 - 50 Dairy Cows	GROUP H2 50 - 70 Dairy Cows	GROUP H3 Over 90 Dairy Cows	F STATISTIC
Feed	15.01	16.16	15.48	0.45
Processing	0.16	0.93	0.01	1.76
Bedding & Supplies	1.64	1.80	1.30	1.29
Breeding	0.75	0.87	0.49	1.35
Vet & Medicine	1.20	1.26	0.92	1.04
Milk Hauling	1.65	1.66	1.69	0.24
Producer Fees	1.22	1.13	1.06	9.81*
Utilities	1.26	0.98	1.26	2.43
Fuel, Oil & Lube	0.66	0.57	0.49	0.97
Rent	0.35	0.27	0.07	1.00
Miscellaneous Expenses	1.24	1.59	1.77	0.78
Hired Labour	2.48	2.14	1.54	0.81
Unpaid Family Labour	6.40	5.46	2.31	34.77*
Operator Labour	7.64	6.37	2.27	35.74*
Insurance & Tax	0.67	0.62	0.58	0.28
Build/Machine Repairs	2.14	2.10	2.10	0.01
User Cost of Buildings	6.12	5.17	5.86	0.79
User Cost of Machinery & Equipment	4.69	3.40	3.08	4.90*
User Cost of Land	0.92	0.82	0.35	2.75
User Cost of Dairy Herd	2.29	2.20	2.17	1.12
Total Variable Cost[b]	**25.10**	**26.38**	**24.55**	**0.84**
Total Labour Cost	**16.52**	**13.96**	**6.11**	**32.12***
TOTAL COP	**58.45**	**54.65**	**44.81**	**13.17***

a * denotes statistical significance at a 95 percent confidence interval
b Average Total Variable Cost excludes labour expenses

materialize only among farms milking over 90 cows. During 1994, herds in Group H3 reported an average total operating expense of $44.81 per hectolitre. This represents a savings in the per unit cost of milk production of $13.64 per hectolitre over Group H1, which sustained the highest average total production cost at $58.45 per hectolitre. Group H2 realized an average total COP value of $54.65 per hectolire, $9.84 per hectolitre greater than that of Group H3. Parallel to 1995, significantly smaller family labour, and operator labour production costs aided Group H3 in achieving a total cost advantage over Groups H1 and H2. As well, during 1994, significantly smaller expenses for producer fees and user cost of farm machinery and equipment also contributed to the lower total operating expenditure for Group H3 than for other groups. Further explanation is provided below.

In 1994, imputed family labour expenditures for the large herd size group (Group H3) differed significantly from family labour of the small and average sized herds groups. Farms milking over 90 head reported an average family labour production expense of $2.31 per hectolitre, less than half of the cost incurred by farms with less than 90 head. Average family labour costs realized by Groups H1 and H2 for the 1994 dairy year were $6.40 per hectolitre and $5.46 per hectolitre, respectively.

Coinciding with family labour costs, the average imputed operator labour expense of the large herd size group differed significantly from operator labour costs reported by small and average sized farms. Decreasing with herd size, operator labour costs estimated for 1994 were $7.64 per hectolitre, $6.37 per hectolitre, and $2.27 per hectolitre for Groups H1, H2, and H3, respectively.

An inverse relationship between category of herd size and 1994 total labour costs was identified. Decreasing as average herd size is increased, average total cost of labour estimates were $16.52 per hctolitre for Group H1, $13.96 per hectolitre for Group H2, and $6.11 per hectolitre for Group H3.

Like total labour costs, average producer fees differed significantly between each study group, decreasing as herd size increased. Herds milking 40 to 50 head (Group H1) reported producer fees to total $1.22 per hectolitre. Farms with 50 to 70 cows milking (Group H2) paid an average of $1.13 per hectolitre in producer fees during 1994 while herds over 90 head (Group H3) realized the lowest average COP value at $1.06 per hectolitre. This significant inverse relationship between producer fees and herd size appears to represent a fixed cost spread over an increasing number of production units.

The average user cost of machinery and equipment for farms in Group H1 was significantly higher than the user costs of machinery and equipment incurred by Group H2 and Group H3 herds. Specifically, farms milking 40 to 50 cows realized an average user cost of $4.69 per hectolitre in 1994. Herds of 50 to 70 head reported a user cost of $3.40 per hectolitre while the average user cost machinery and equipment for farms milking more than 90 head was $3.08 per hectolitre.

6.2.1.4 *Summary of economic production costs derived according to herd size*

Table 6.10 summarizes the average annual total costs of production calculated for each study group and cites the percentage change in average total operating expenditures between 1994 and 1996. The F statistic from the single factor / one-way ANOVA performed for each year is also presented. Refer to Appendix D for a statistical summary of the analysis of variance performed.

When comparing total costs of production across years, the large herd size group (Group H3) is the only study group for which a significant change in total operating expenses is seen in 1996, compared to 1995. The 11.03 percent increase in total expenditures reported by the group between 1995 and 1996 was the result of significantly higher costs for feed, producer fees and hired labour, and a higher user cost of cattle. These expenses, plus a higher level of imputed costs of family labour, contributed to a significant increase in estimated total costs for farms milking over 90 head between 1994 and 1996. The rise in imputed family labour costs between 1994 and 1996 resulted from of a significantly higher number of total labour hours worked by the farm family during 1996 as the wage rate assigned to family labour decreased from $9.53 per hour in 1994 to $9.34 per hour in 1996.

It is interesting to note that although the total cost of milk production estimated for the small herd size group (Group H1) did not differ significantly between 1994 and 1996, these farms milking 40 to 50 head reported unpaid family labour expenses to fall by $3.34 per hectolitre during this time period. It can therefore be suggested that over time Alberta's smaller herds have become increasingly more labour efficient. The validity of this observation will be examined in detail in Section 6.3 when the physical and economic efficiency of herd size groups is estimated.

The hypothesis that large dairy operations have a cost competitive advantage over smaller herds, due to economies of size, was validated for the 1995 and 1994 dairy years. Specifically, operating expenses were found to decrease significantly for farms milking over 90 cows. The 11.03 percent increase in total operating expenses between 1995 and 1996 prevented the large herd size group from exhibiting its total cost advantage in 1996. This may suggest that the province's largest herds may be losing their cost competitive position. Perhaps controlling rising feed, and hired and family labour costs and a higher user costs of cattle would allow Group H3 to regain its total cost advantage. The examination of production cost data of more recent years is suggested in order to address this concern.

The evidence that economies of size exist in the Alberta dairy industry follows the observation made by Lazarus et al (1989) that large farms are more prosperous than smaller herds due to the fact that overhead costs are spread over more producing units. Recall from Section 4.1.3 of this thesis, that Barichello and Stennes (1994) took their explanation of economies of size a step further than Lazarus et al (1989), stating: "despite the extra variable costs that appear to arise with large sized operations, the potential savings in fixed costs and unpaid labour is large enough to give cost advantages to larger farms," (p.19). The estimated costs of production derived in this thesis did not entirely confirm this inference made by Barichello and Stennes (1994).

Consistent with the findings of Barichello and Stennes (1994), the large dairy herds examined in this study achieved a cost advantage through lower use of unpaid labour by the farm family and farm manager. Also following the findings of Barichello and Stennes (1994), the largest dairy operations examined exhibited lower average fixed costs than the small and average sized farms. In contrast to the conclusion of Barichello and Stennes (1994), the operating costs of Alberta dairy farms computed for this thesis, reveal that the variable

TABLE 6.10: Changes in Average Total Costs of Production According to Herd Size: 1994-1996 ($/hl)[a]

STUDY GROUP	1994	1995	% Change	F STAT 1994-95	1996	% Change	F STAT 1995-96	F STAT 1994-96
40 - 50 Cows	58.45	55.81	- 4.52	0.61	56.22	+ 0.73	0.02	0.44
50 - 70 Cows	54.65	55.38	+ 1.34	0.14	54.80	- 1.05	0.08	0.01
Over 90 Cows	44.81	45.59	+ 1.43	0.07	50.62	+ 11.03	5.04*	5.84*

[a] * denotes statistical significance at a 95 percent confidence interval

expenses of farms milking more than 90 head do not differ significantly from those of smaller herds.

6.2.2 Investigating Economies of Yield: Milk Yield Distribution of Data

6.2.2.1 Estimated economic costs of production for the 1996 dairy year

Estimated 1996 producer costs of production, grouped on the basis of differences in average milk yield per farm, are noted below in Table 6.11. The F statistics from the single factor / one-way ANOVA preformed for individual production expenses are presented to indicate whether or not each computed cost of production differs significantly between the three groups. If a given cost was identified as being significantly different among the study groups, three additional analyses of variance were conducted to assess the source of the variation. Refer to Appendix E for a statistical summary of each analysis of variance

Average total operating expenses derived for the 1996 dairy year were found to decrease as milk yield per cow increased, with a significant difference in total costs detected between the low yielding group (Group M1) and the high yielding group (Group M3). Therefore, the existence of economies of milk yield in Alberta's dairy industry can be inferred when moving from an average production level below 80 hectolitres of milk per cow to an average milk yield of over 90 hectolitres per cow. Estimated average total costs of production calculated for each group are as follows: $57.08 per hectolitre for Group M1, $53.41 per hectolitre for Group M2, and $51.43 per hectolitre for Group M3. To provide further insight into the composition of costs for the 1996 dairy year, significant differences among study groups for the identified operating expenses are discussed below.

Parallel with average total production costs, a significant difference in producer fees was observed between the low yielding group (Groups M1) and the high yielding group (Group M3). Farms realizing an average production level below 80 hectolitres per cow reported producer fees totaling $1.03 per hectolitre. Herds averaging over 90 hectolitres of milk per cow reported an average producer fee expense of $1.00 per hectolitre.

The user cost of farm machinery and equipment was found to differ significantly between Group M1 and Group M2. Specifically, herds with an average milk yield below 80 hectolitres of milk per cow sustained an average user cost of $4.23 per hectolitre. Farms with an average production per cow between 80 and 90 hectolitres reported an average user cost of $2.90 per hectolitre. Although Group M2 achieved a $1.33 per hectolitre cost advantage over Group M1, no significant difference in the market value of farm machinery and equipment was found between the two study groups. Further analysis revealed that computed user costs of machinery and equipment also did not differ significantly among groups when figures were expressed as absolute numbers (as opposed to being examined on a per hectolitre basis). It is thus concluded that the significantly higher user cost of machinery and equipment reported by low yielding farms was the result of economies of milk yield.

An inverse relationship between milk yield per cow and the average user cost of cattle was identified. Decreasing with increased production levels per cow, estimated user costs of cattle are as follows: $1.96 per hectolitre, $1.86 per hectolitre, and $1.72 per hectolitre for Groups M1, M2, and M3 respectively. An investigation of the individual components

TABLE 6.11: 1996 Average Dairy Costs of Production by Cost Category According to Milk Yield ($/hl)[a]

COST ITEM	GROUP M1 Under 80 hl/cow	GROUP M2 80 - 90 hl/cow	GROUP M3 Over 90 hl/cow	F STATISTIC
Feed	20.05	19.11	18.94	0.55
Processing	0.20	0.03	0.15	2.71
Bedding & Supplies	1.67	1.98	1.82	1.07
Breeding	0.66	0.72	0.70	0.13
Vet & Medicine	1.22	1.33	1.30	0.13
Milk Hauling	1.84	1.78	1.81	0.77
Producer Fees	1.03	1.01	1.00	3.37*
Utilities	1.24	1.12	1.06	0.95
Fuel, Oil & Lube	0.91	0.71	0.622	2.36
Rent	0.75	0.37	0.69	0.65
Miscellaneous Expenses	1.18	1.82	1.73	1.18
Hired Labour	2.44	2.76	1.84	0.83
Unpaid Family Labour	2.63	2.12	2.16	0.46
Operator Labour	7.66	5.47	5.66	2.89
Insurance & Tax	0.72	0.70	0.68	0.05
Build/Machine Repairs	1.91	1.93	2.22	0.71
User Cost of Buildings	4.23	5.14	3.91	1.36
User Cost of Machinery &Equipment	4.23	2.90	3.04	5.33*
User Cost of Land	0.58	0.56	0.38	1.13
User Cost of Dairy Herd	1.96	1.86	1.72	13.63*
Total Variable Cost[b]	**30.73**	**29.98**	**29.82**	**0.28**
Total Labour Cost	**12.72**	**10.34**	**9.65**	**8.64***
TOTAL COP	**57.08**	**53.41**	**51.43**	**4.06***

a * denotes statistical significance at a 95 percent confidence interval

b Average Total Variable Cost excludes labour expenses

comprising the user cost of cattle (refer back to Equation 13) showed no significant differences in the market values of cattle between the three study groups. The inverse relationship between the user cost of cattle and milk yield is, therefore, solely the result of economies of yield.

Although differences in 1996 average hired labour costs, average family labour costs and average operator labour costs did not differ significantly between the three categories of milk yield, the average total labour expense of Group M1 herds was significantly higher compared to the average total labour cost of Group M2 and Group M3. Specifically, farms with an average milk yield below 80 hectolitres of milk per cow reported an average total labour expense of $12.72 per hectolitre. The estimated average total labour expense for milking herds averaging between 80 and 90 hectolitres per cow was $10.34 per hectolitre. Farms with an average milk yield greater than 90 hectolitres of milk per cow reported a total labour cost of $9.65 per hectolitre.

6.2.2.2 Estimated economic costs of production for the 1995 dairy year

Estimated farm level costs of production, expressed according to the average milk yield per cow of each farm in the 1995 data set, are presented in Table 6.12. The F statistic from the single factor / one-way ANOVA performed for each production expense is also reported. If a given cost was identified as being significantly different among the study groups, three additional analyses of variance were run to determine the source of the variation. A statistical background of the various analyzes of variance conducted is provided in Appendix E.

Total dairy costs of production estimated for the 1995 dairy year averaged $57.09 per hectolitre for the low yielding group (Group M1), $51.03 per hectolitre for the average yielding group (Group M2), and $51.85 per hectolitre for the high yielding group (Group M3). A significant difference in average total costs was observed only between Groups M1 and M2. Thus, for 1995 as for 1996, it is concluded that economies of milk yield do exist in Alberta's dairy industry when moving from an average production level below 80 hectolitres of milk per cow to an average milk yield over 90 hectolitres per cow. Significant differences detected for individual cost items are discussed below.

Veterinary and medicine expenses were found to be significantly higher for the average milk yield group during 1995. Specifically, farms which average 80 to 90 hectolitres of milk per cow, reported an average veterinary and medicine cost of $1.34 per hectolitre. Veterinary and medicine production costs estimated for the low yielding group and the high yielding group were $1.00 per hectolitre and $0.99 per hectolitre respectively.

At $2.94 per hectolitre, the user cost of farm machinery and equipment incurred by the average yielding group of farms was found to be significantly lower than the user cost incurred by the low and high yielding study groups. Group M1 reported an average user cost of $4.48 per hectolitre, $1.54 per unit greater than that of Group M2. Group M3 realized an average user cost of machinery and equipment of $4.27 per hectolitre, $1.33 per unit higher than that of Group M2.

Parallel to the cost analysis for 1996, the user cost of cattle was found to decrease as milk yield increased. However, in contrast to 1996 estimations, a significant difference in the

TABLE 6.12: 1995 Average Dairy Costs of Production by Cost Category According to Milk Yield ($/hl)[a]

COST ITEM	GROUP M1 Under 80 hl/cow	GROUP M2 80 - 90 hl/cow	GROUP M3 Over 90 hl/cow	F STATISTIC
Feed	16.97	15.79	16.07	1.49
Processing	0.08	0.15	0.09	0.64
Bedding & Supplies	1.41	1.78	1.69	2.28
Breeding	0.59	0.72	0.69	0.44
Vet & Medicine	1.00	1.34	0.99	4.21*
Milk Hauling	1.85	1.79	1.82	2.23
Producer Fees	0.97	0.97	0.96	0.18
Utilities	1.19	1.19	1.01	0.72
Fuel, Oil & Lube	0.73	0.62	0.63	0.50
Rent	0.31	0.30	0.11	0.77
Miscellaneous Expenses	1.42	1.49	1.69	0.23
Hired Labour	2.27	1.94	2.10	0.19
Unpaid Family Labour	5.13	4.09	3.97	2.22
Operator Labour	7.31	5.72	5.60	1.94
Insurance & Tax	0.80	0.84	0.63	1.31
Build/Machine Repairs	1.98	1.97	1.96	0.00
User Cost of Buildings	5.76	4.65	5.11	1.49
User Cost of Machinery &Equipment	4.48	2.94	4.27	7.13*
User Cost of Land	0.62	0.67	0.48	0.55
User Cost of Dairy Herd	2.19	2.08	1.99	7.84*
Total Variable Cost[b]	**26.54**	**26.13**	**25.73**	**0.25**
Total Labour Cost	**14.71**	**11.48**	**11.67**	**2.27**
TOTAL COP	**57.09**	**51.03**	**51.85**	**4.05***

a * denotes statistical significance at a 95 percent confidence interval

b Average Total Variable Cost excludes labour expenses

user cost of cattle was detected only when expenses were expressed on a per hectolitre basis. The significantly higher user cost of cattle reported by low yielding farms is therefore the result of economies of milk yield.

6.2.2.3 Estimated economic costs of production for the 1994 dairy year

Dairy production costs estimated for the 1994 dairy year are presented in Table 6.13. according to the average milk production per cow of each study group. To reveal the significance of cost differences, the F statistic of the single factor / one-way ANOVA performed for each operating expense is also stated. If a given cost was identified as being significantly different among the study groups, three additional analyses of variance were run to determine the source of the variation. Refer to Appendix E for a statistical summary of each ANOVA test.

Estimated average total costs of production did not differ significantly between the three categories of milk yield. Thus, the existence of economies of milk yield among Alberta dairy producers can not be inferred for 1994 total production cost data constructed as outlined in Chapter 5. When examining individual cost items, the user cost of cattle was the only operating expense which displayed a significant difference among study groups during the 1994 dairy year.

The average user cost of cattle for farms averaging a milk yield below 80 hectolitres per cow was found to be significantly lower than the average user cost of cattle incurred by herds with an average production level greater than 90 hectolitres of milk per cow. Specifically, Group M1 reported a user cost of cattle of $2.30 per hectolitre while Group M3 realized a user cost of $2.06 per hectolitre. No significant difference in the market value of cattle was detected between the three study groups; thus as was found for 1996 and 1995, the significantly lower user cost reported by Group M1 is attributed to economies of milk yield.

6.2.2.4 Summary of economic production costs derived according to milk yield

A summary of changes in average annual total operating expenditures for each category of milk production per cow is given in Table 6.14. To identify the significance of these average total cost changes, the E statistic from the single factor / one-way ANOVA is presented. The statistical background for the analysis of variance is provided in Appendix E.

Between 1994 and 1996, average total costs of production remained consistent for each study group. No significant change in annual total expenses was detected for any of the milk yield categories.

The hypothesis that economies of milk yield exist within Alberta's dairy industry was confirmed by the cost estimations of this study for both the 1996 and 1995 dairy years. Specifically, economies of milk yield were observed when moving from an average production level below 80 hectolitres of milk per cow to an average milk yield over 90 hectolitres per cow. This total cost disadvantage sustained by the low yielding farm group is credited to a significantly higher user cost of machinery and equipment and a higher user cost of cattle reported by these farms during 1996 and 1995. No cost saving incentives associated with increased production levels per cow were identified for the 1994 dairy year.

TABLE 6.13: 1994 Average Dairy Costs of Production by Cost Category According to Milk Yield ($/hl)[a]

COST ITEM	GROUP M1 Under 80 hl/cow	GROUP M2 80 - 90 hl/cow	GROUP M3 Over 90 hl/cow	F STATISTIC
Feed	15.36	14.85	16.07	0.77
Processing	0.10	0.16	0.01	2.88
Bedding & Supplies	1.66	1.57	1.62	0.08
Breeding	0.73	0.65	0.75	0.18
Vet & Medicine	1.14	1.01	1.26	0.79
Milk Hauling	1.65	1.62	1.69	1.29
Producer Fees	1.18	1.16	1.11	1.86
Utilities	1.22	1.04	1.23	1.09
Fuel, Oil & Lube	0.65	0.69	0.54	0.91
Rent	0.30	0.15	0.14	1.04
Miscellaneous Expenses	1.26	1.53	1.53	0.66
Hired Labour	2.83	1.39	2.30	2.95
Unpaid Family Labour	5.16	5.32	4.31	1.60
Operator Labour	5.87	6.33	4.87	1.65
Insurance & Tax	0.64	0.72	0.63	0.38
Build/Machine Repairs	2.26	2.25	1.98	0.37
User Cost of Buildings	5.32	5.18	6.05	0.78
User Cost of Machinery &Equipment	4.49	3.32	3.63	2.99
User Cost of Land	1.00	0.65	0.58	2.96
User Cost of Dairy Herd	2.30	2.12	2.06	10.49*
Total Variable Cost[b]	**25.23**	**24.42**	**25.95**	**0.75**
Total Labour Cost	**13.86**	**13.05**	**11.48**	**1.44**
TOTAL COP	**55.11**	**51.71**	**52.36**	**1.35**

a * denotes statistical significance at a 95 percent confidence interval
b Average Total Variable Cost excludes labour expenses

TABLE 6.14 Changes in Average Total Costs of Production According to Milk Yield: 1994-1996 ($/hl)[a]

STUDY GROUP	1994	1995	% Change	F STAT 1994-95	1996	% Change	F STAT 1995-96	F STAT 1994-96
Under 80hl/cow	55.11	57.09	+ 3.59	0.66	57.08	- 0.02	5.98E-06	0.65
80 - 90 hl/cow	51.71	51.03	- 1.32	0.13	53.41	+ 4.66	1.56	0.96
Over 90hl/cow	52.36	51.85	- 0.97	0.04	51.43	- 0.81	0.03	0.17

a * denotes significance at a 95 percent confidence interval

Recall from a discussion in the literature review (Section 4.1), there exists much controversy over the use of farm-level dairy cost data in analysis. Richards and Jeffrey (1996), unwilling to dismiss the difficulties inherent in using farm cost data, suggest that producer efficiency and its relationship with production costs is a more appropriate measure of competitiveness than simply comparing average total costs of production. The researchers claim that producer efficiency provides an explanation for differences in farm costs and therefore facilitates the development of a strategic plan for the business to follow.

Following Richards and Jeffrey (1996), this thesis incorporates efficiency measures into its portfolio of Alberta dairy farm competitiveness. Following Jeffrey (1992) and Phillips et al (1989), Section 6.3 measures the technical and economic efficiency for the various study groups using a farm management approach.

6.3 EFFICIENCY

As previously stated in Section 4.3.1 of the literature review, Jeffrey (1992), explains that there exists within economics various interpretations and applications of efficiency. In examining the performance of the dairy sector, technical and economic efficiency are the most commonly applied concepts (re: Bravo-Ureta, 1986; Bravo-Ureta and Rieger, 1991; Jeffrey, 1992; Richards and Jeffrey, 1996)

6.3.1 Physical Efficiency

Recall technical or physical efficiency as defined by Black (1997): "efficiency concerned with getting the largest possible outputs for given inputs, or the smallest possible inputs for given outputs. This is efficiency in production," (p.463). This study estimates a farm's efficiency in production by computing its milk productivity and labour productivity. As previously revealed, milk productivity is identified by the average hectolitres of milk produced per cow on each farm while labour productivity is expressed in terms of cows per worker equivalent. Section 6.3.1.1 investigates any possible benefits of scale by measuring physical efficiency when data are organized according to farm herd size. In order to determine possible advantages of yield, Section 6.3.1.2 reviews milk and labour productivity when surveyed farms are arranged with respect to average milk yield.

6.3.1.1 Calculated physical efficiency: herd size distribution of data

Table 6.15 outlines annual measures of physical efficiency for each category of herd size in terms of labour productivity. The significance of differences in the estimated physical efficiency for each study group is revealed by the F statistic. When a given labour productivity estimate was identified as being significantly different among the categories of herd size, three additional analyses of variance were conducted to assess the basis of the detected variation. Refer to Appendix F for a statistical summary of each single factor / one-way ANOVA conducted.

Reporting a significantly higher number of cows per worker equivalent in each of the three years examined, farms milking over 90 head (Group H3) were found to be the most labour-efficient category of herd size. This significantly higher level of labour productivity

Table 6.15: Labour Productivity According to Farm Herd Size: 1994 - 1996 (cows/worker equivalent)[a]

LABOUR PRODUCTIVITY (cows/worker equivalent)	GROUP H1 40 - 50 Dairy Cows	GROUP H2 50 - 70 Dairy Cows	GROUP H3 Over 90 Dairy Cows	F STATISTIC
1996	31.04	30.81	46.58	22.32*
1995	22.13	26.16	36.44	13.31*
1994	24.02	23.48	37.08	8.00*

a * denotes statistical significance at a 95 percent confidence interval

reported by the large herd size group reveals a link between increased herd size, labour productivity, and the lower total labour cost estimated for Group H3 in Section 6.2.1. Specifically, it is suggested that more efficient use of unpaid family labour and operator labour by herds milking over 90 cows facilitates a lower average per unit cost of farm labour. Perhaps the capital inventory employed by the large herd size group promotes a significantly greater level of labour productivity, and therefore significantly lowers total labour costs on farms milking over 90 cows. Further research on the role of labour-saving technology in Alberta's dairy industry is suggested.

Recall from Section 6.2.1.4 that the family labour expenses of the small herd size group (Group H1) were found to decrease by $3.34 per hectolitre from 1994 to 1996. An ANOVA test comparing the group's labour productivity between 1994 and 1996 was conducted to see if Alberta's smaller herds have become increasingly more labour efficient.[24] Results showed the cows per worker equivalent reported by Group H1 to significantly increase between 1994 and 1996; however, this encouraging trend is outweighed by the fact that the imputed labour productivity of the average sized and large sized herds also rose during this time period.

A measure of physical efficiency, expressed as milk productivity per cow, is presented in Table 6.16 for each subgroup of herd size. The F statistic of the single factor / one-way ANOVA performed to reveal the significance of differences in average farm production per cow is indicated. A statistical summary of the analysis of variance conducted is provided in Appendix F-2.

Milk productivity per cow estimated for the three categories of herd size did not differ significantly. It is concluded that no relationship is evident between scale and herd productivity. This inference follows the findings of Section 6.1.1 of this thesis which previously noted that there exists no correlation between average milking herd size and average milk yield per cow. Again, the suggestion made by Barichello et al (1996) that there is a direct relationship between farm herd size and cow productivity (refer to Section 4.4) is not supported.

6.3.1.2 Calculated physical efficiency: milk yield distribution of data

Table 6.17 presents a measure of physical efficiency, expressed in terms of labour productivity, for each category of milk yield. The significance of differences in labour productivity between study groups is revealed by the F statistic of the single factor / one-way ANOVA. Refer to Appendix G for a statistical summary of the ANOVA analysis.

Labour productivity estimates did not differ significantly among the three categories of milk yield. This finding provides an explanation as to why average per unit hired labour, family labour, and operator labour costs imputed in Section 6.2.2 were not statistically different between the study groups. The labour productivity of Alberta dairy producers is apparently not influenced by farm milk yield, but as was observed in Section 6.3.1.1, efficient use of labour is induced by economies of size. Table 6.18 outlines the average

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[24] Refer to Appendix R for a statistical summary of the ANOVA results.

Table 6.16: Milk Productivity per Cow According to Farm Herd Size: 1994 - 1996 (hl milk/cow)[a]

MILK PRODUCTIVITY (hl milk/cow)	GROUP H1 40 - 50 Dairy Cows	GROUP H2 50 - 70 Dairy Cows	GROUP H3 Over 90 Dairy Cows	F STATISTIC
1996	84.85	88.30	82.98	0.58
1995	82.04	83.89	82.46	0.12
1994	76.78	84.48	82.87	2.16

a * denotes statistical significance at a 95 percent confidence interval

Table 6.17: Labour Productivity According to Farm Milk Yield: 1994 - 1996 (cows/worker equivalent)[a]

LABOUR PRODUCTIVITY (cows/worker equivalent)	GROUP M1 Under 80 hl/cow	GROUP M2 80 - 90 hl/cow	GROUP M3 Over 90 hl/cow	F STATISTIC
1996	35.47	35.37	35.49	0.00
1995	29.50	27.46	26.53	0.51
1994	29.60	24.41	26.23	1.32

a * denotes statistical significance at a 95 percent confidence interval

Table 6.18: Milk Productivity per Cow According Farm Milk Yield: 1994 - 1996 (hl milk/cow)[a]

MILK PRODUCTIVITY (hl milk/cow)	GROUP M1 Under 80 hl/cow	GROUP M2 80 - 90 hl/cow	GROUP M3 Over 90hl/cow	F STATISTIC
1996	73.52	85.15	95.57	98.57*
1995	70.69	85.90	96.33	165.13*
1994	71.82	85.77	96.76	158.62*

a * denotes statistical significance at a 95 percent confidence interval

productivity per cow within each study group.

The significance of differences in this efficiency measure is indicated by the F statistic of the single factor / one-way ANOVA. If productivity per cow estimates were found to be significantly different among the subgroups of milk yield, three additional analyses of variance were performed to determine from which group or groups the detected variation was originating. A statistical summary of each analysis of variance conducted is provided in Appendix G.

With milk production per cow acting as the distinguishing factor between Groups M1, M2, and M3, it is expected that the estimated productivity per cow of each group differ significantly for the three years examined. This observation follows the findings of Section 6.1.2 of this study where milk yield per cow was addressed with respect to the data characteristics of each study group.

It is important to note that because surveyed farms were grouped according to average milk production per cow per year, the examination of economies of milk yield in Section 6.2.2 addressed the impact of physical efficiency on costs of production. Recall that when average milk productivity per cow per farm moved from a level below 80 hectolitres to a level greater than 90 hectolitres, average total costs of production decreased for the 1996 and 1995 dairy years. Also as previously indicated, no cost saving incentives associated with increased milk productivity were identified for the 1994 dairy year.

6.3.2 Economic Efficiency

The definition of economic efficiency utilized in this study is adopted from Jeffrey (1992): "the ability to choose the technically efficient output/input combination that optimizes a decision-maker's goal(s), given relative output and input prices," (p.3). Also employed from Jeffrey (1992), the interpretation of 'optimizing a decision-maker's goal' in terms of economic efficiency is to minimize total costs of production. Thus, economic efficiency is measured in terms of cost efficiency by means of cost control ratios. Once again, any possible benefits to scale and yield are examined. Section 6.3.2.1 determines possible advantages of size by computing cost ratios when data are organized according to farm herd size. Section 6.3.2.2 inquires into possible benefits of yield by comparing cost ratios across categories of milk production per cow. Recall that cost control ratios reveal a farm's ". . . ability to convert input costs into dairy sales," (Jeffrey, 1992; p.7). Each ratio is expressed in terms of costs per dollar of dairy enterprise revenue; therefore, the smaller the ratio, the more cost efficient the given dairy operation.

It is important to note that the costs of production, expressed on a per hectolitre basis, used to calculate the described cost control ratios are also measures of economic efficiency. Therefore, the conclusions drawn from Section 6.2 of this thesis provide another extension of the cost efficiency of Alberta dairy farms.

6.3.2.1 Calculated economic efficiency: herd size distribution of data

6.3.2.1.1 Calculated cost efficiency for the 1996 dairy year

Table 6.19 presents the estimated cost efficiency of each category of herd size for 1996. The F statistic of the single factor / one-way ANOVA indicates the significance of differences in efficiency values. When a given measure of cost efficiency was found to be significantly different among Groups H1, H2, and H3, three additional analyses of variance were run to determine from which group or groups the detected variation was originating. Refer to Appendix H for a statistical summary of each ANOVA test.

During 1996, cost control ratios computed for feed, capital, and the total cost of production did not differ significantly between study groups. However, the labour cost control ratio calculated for the large herd size group (Group H3) was significantly lower compared to the labour cost control ratios of the small and average sized herd groups (Group H1 and Group H2). This significantly higher labour cost efficiency demonstrated by farms milking over 90 cows is the result of the significantly lower 1996 per unit total labour production cost imputed for the large herd size group in Section 6.2.1.1. This labour cost efficiency of Group H3 reconfirms the link between increased herd size, labour efficiency, and the lower total labour costs identified above in Section 6.3.1.1. Again, it is suggested that economies of size facilitates the adoption of labour-saving technology which in turn lowers the labour costs of farms milking over 90 cows. For example, milking parlours, robotic milkers, and computerized feeding systems are more feasible for large herds.

6.3.2.1.2 Calculated cost efficiency for the 1995 dairy year

The estimated cost efficiency of each study group for the 1995 dairy year is displayed in Table 6.20. The F statistic of the single factor / one-way ANOVA indicates the significance of differences in efficiency values. If a cost efficiency estimate was found to be significantly different among the categories of herd size, three additional analyses of variance were conducted to assess from which group or groups the detected variation was originating. Statistical summaries of the ANOVA analyses are found in Appendix H.

The cost control ratios calculated for feed and the user cost of farm capital did not differ significantly between categories of herd size during 1995. As was observed in the 1996 data set, the large herd size group (Group H3) reported a significantly lower labour cost control ratio. This finding corresponds to the significantly lower 1995 per unit total labour expense (due to significantly lower family and operator labour costs) reported by Group H3 in Section 6.2.1.2. Once again, a relationship between herd size, labour productivity, and lower labour costs is identified. It is therefore appears that labour-saving technology employed by the province's largest dairy operations tends to reduce imputed family labour and operator labour costs, allowing farms milking over 90 head to be more cost efficient in their use of labour.

Reflecting a significantly lower 1995 average total cost of production, farms milking over 90 head were found to be the most cost efficient overall, reporting a significantly smaller total cost control ratio compared to farms with less than 90 milking cows. In fact, in terms of overall economic efficiency, Group H3 may be considered the only cost-efficient

TABLE 6.19: Economic Efficiency: 1996 Cost Control Ratios According to Farm Herd Size[a]

COST CONTROL RATIO	GROUP H1 40 - 50 Dairy Cows	GROUP H2 50 - 70 Dairy Cows	GROUP H3 Over 90 Dairy Cows	F STATISTIC
Feed Cost	0.36	0.33	0.35	0.82
Labour Cost	0.21	0.20	0.15	9.36*
Capital Cost	0.17	0.17	0.17	0.05
Total Cost	0.98	0.96	0.89	2.82

a * denotes statistical significance at a 95 percent confidence interval

TABLE 6.20: Economic Efficiency: 1995 Cost Control Ratios According to Farm Herd Size[a]

COST CONTROL RATIO	GROUP H1 40 - 50 Dairy Cows	GROUP H2 50 - 70 Dairy Cows	GROUP H3 Over 90 Dairy Cows	F STATISTIC
Feed Cost	0.30	0.31	0.31	0.04
Labour Cost	0.31	0.27	0.11	19.39*
Capital Cost	0.20	0.22	0.20	0.58
Total Cost	1.05	1.04	0.84	5.43*

a * denotes statistical significance at a 95 percent confidence interval

category of herd size. Because the total cost control ratios of the small herd size group (Group H1) and the average herd size group (Group H2) are greater than 1.00, the estimated economic costs of these two groups were greater than the revenue of their dairy enterprises.

6.3.2.1.3 Calculated cost efficiency for the 1994 dairy year

Table 6.21 presents the estimated cost efficiency of each category of herd size for the 1994 dairy year. The significance of differences in the estimated efficiency of study groups is revealed by the F statistic of the single factor / one-way ANOVA. If cost efficiency measures were found to differ significantly among Groups H1, H2, and H3, three additional analyses of variance were performed to determine from which group or groups the detected variation was originating. Refer to Appendix H for statistical summaries of all ANOVA results.

The estimated cost efficiency of each study group for the 1994 dairy year mirrors the 1995 efficiency measures. As was observed with the 1995 data set, the cost control ratios derived for feed and the user cost of capital did not differ significantly between the three categories of herd size. Farms milking over 90 head (Group H3) reported a significantly lower cost control ratio for labour. As in 1995, this result coincides with significantly lower 1994 family labour and operator labour expenses estimated for the large herd size group in Section 6.2.1.3. As when investigating labour productivity in Section 6.3.1.1, and when examining the cost efficiency of categories of herd size during 1996 and 1995, a link between herd size, labour productivity, and the cost efficient use of labour is recognized.

As was observed with the cost ratios derived for the 1995 data set, the large herd size group was found to be the most cost efficient overall with a significantly lower total cost of production cost control ratio. This finding is a reflection of a significantly lower total production cost imputed for Group H3 in Section 6.2.1.3. Again, farms milking over 90 cows may be considered the only cost-efficient category of herd size. Farms milking between 40 and 50 cows (Group H1) reported a total cost control ratio greater than 1.00, indicating that estimated 1994 economic costs of production were greater than the dairy enterprises' sources of revenue. Herds comprised of 50 to 70 head (Group H2) broke even during 1994 with a total cost control ratio of 1.00.

Recall from Section 6.2.1.4 that the family labour expenses of the small herd size group (Group H1) were found to decrease by $3.34 per hectolitre from 1994 to 1996. It was thus assumed that farms milking between 40 and 50 head have become increasingly more labour efficient. An ANOVA test comparing the group's labour cost control ratios for 1994 and 1996 was conducted to verify this inference.[25] Results showed the labour cost control ratio reported by Group H1 to significantly decrease over this time period. The average sized group (Group H2) also reported a fall in its labour cost control ratio between 1994 and 1996; however, the large herd size group showed no significant change in its labour cost control ratio. It can therefore be concluded that between 1994 and 1996 the small and average herd

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[25] Refer to Appendix R for a statistical summary of the ANOVA results.

TABLE 6.21: Economic Efficiency: 1994 Cost Control Ratios According to Farm Herd Size[a]

COST CONTROL RATIO	GROUP H1 40 - 50 Dairy Cows	GROUP H2 50 - 70 Dairy Cows	GROUP H3 Over 90 Dairy Cows	F STATISTIC
Feed Cost	0.30	0.30	0.28	0.10
Labour Cost	0.33	0.25	0.11	18.64*
Capital Cost	0.29	0.21	0.21	2.50
Total Cost	1.16	1.00	0.83	5.38*

a * denotes statistical significance at a 95 percent confidence interval

size groups increased their labour productivity while at the same time decreasing total labour costs.

6.3.2.2 Calculated economic efficiency: milk yield distribution of data

6.3.2.2.1 Calculated cost efficiency for the 1996 dairy year

The 1996 cost control ratios calculated for each category of farm milk yield are found in Table 6.22. The F statistic of the single factor / one-way ANOVA indicates the significance of differences in the estimated efficiency values. When a specific cost efficiency estimate was found to differ significantly among the categories of milk yield, three additional analyses of variance were performed to assess from which group or groups the detected variation originated. Appendix I provides statistical summaries of all ANOVA analyses.

Cost control ratios computed for feed and capital were not significantly different among the three study groups for 1996. Farms averaging less than 80 hectolitres of milk per cow (Group M1) reported a significantly higher labour cost control ratio compared to farms with an average production level above 80 hectolitres of milk per cow (Groups M2 and M3). This finding is a reflection of the significantly higher 1996 total labour expense estimated for the low yielding group in Section 6.2.2.1. Because the individual cost components comprising Group M1's total labour expense (hired, family, and operator) did not differ significantly during 1996, and due to the fact that labour productivity measures for 1996 were not significantly different among study groups, the cost inefficiency reported by the low yielding group is considered to be the result of economies of yield. It is thus implied that there exits no relationship between labour productivity and labour cost efficiency. It can therefore be suggested that unlike the differentiation in capital inventory identified between groupings of herd size, the technology employed by the three categories of milk yield is more uniform, resulting in non-significant differences in labour productivity.

Although the total cost of production ratio imputed for each category of milk yield did not differ significantly, it is worth noting that because the efficiency ratio for the average and high yielding groups were below 1.00, revenues of these dairy enterprises were greater than estimated economic production costs. The low yielding group; however, reported dairy enterprise revenues to equal costs of production with a cost ratio of 1.00.

6.3.2.2.2 Calculated cost efficiency for the 1995 dairy year

Table 6.23 presents the estimated 1995 cost efficiency of each category of milk yield. The significance of differences in the calculated efficiency is revealed by the F statistic of the single factor / one-way ANOVA. When cost efficiency values were found to differ significantly among Groups H1, H2, and H3, three additional analyses of variance were performed to determine from which group or groups the detected variation was originating. Refer to Appendix I for a statistical summary for each analysis of variance conducted.

As was observed for the 1996 dairy year , the cost control ratio for feed, and total production costs did not differ significantly between categories of milk yield. As with 1996 cost efficiency results, the average and high yielding groups (Group M2 and Group M3) reported dairy enterprise revenues to be greater than estimated production costs. The low

TABLE 6.22: Economic Efficiency: 1996 Cost Control Ratios According to Farm Milk Yield[a]

COST CONTROL RATIO	GROUP M1 Under 80 hl/cow	GROUP M2 80-90 hl/cow	GROUP M3 Over 90 hl/cow	F STATISTIC
Feed Cost	0.35	0.33	0.33	0.33
Labour Cost	0.22	0.18	0.17	6.58*
Capital Cost	0.19	0.18	0.16	1.21
Total Cost	1.00	0.92	0.91	2.39

a * denotes statistical significance at a 95 percent confidence interval

TABLE 6.23: Economic Efficiency: 1995 Cost Control Ratios According to Farm Milk Yield[a]

COST CONTROL RATIO	GROUP M1 Under 80 hl/cow	GROUP M2 80-90 hl/cow	GROUP M3 Over 90 hl/cow	F STATISTIC
Feed Cost	0.31	0.30	0.30	0.55
Labour Cost	0.27	0.22	0.21	1.92
Capital Cost	0.24	0.20	0.22	3.63*
Total Cost	1.06	0.96	0.96	1.91

a * denotes statistical significance at a 95 percent confidence interval

yield group (Group M1) saw total operating expenses exceed revenue with an overall cost ratio of 1.06.

In contrast to the cost efficiency measures derived for 1996, labour cost control ratios were not significantly different between study groups during 1995. This finding corresponds to 1995 total labour cost estimations in Section 6.2.2.2 not differing significantly between categories of milk yield.

The capital cost control ratio calculated for the low yielding group was significantly higher than that of the average yielding group during 1995. A correlation between this observation and Group M2 reporting a significantly lower 1995 per hectolitre user cost of farm machinery and equipment compared to Group M1 in Section 6.2.2.2 is identified.

6.3.2.2.3 Calculated cost efficiency for the 1994 dairy year

Estimated 1994 cost efficiency of each subgroup of milk yield is presented in Table 6.24. The F statistic of the single factor / one-way ANOVA indicates the significance of differences in efficiency measures. When cost efficiency values differed significantly among study groups, three additional analyses of variance were performed to assess from which group or groups the detected variation was originating. Appendix I provides statistical summaries of each ANOVA test.

A significant difference in computed cost control ratios was not detected among study groups. Each category of milk yield demonstrated the same level of cost efficiency with respect to feed, labour, capital, and total costs during the 1994 dairy year. This insignificance in cost control ratio differences corresponds to an insignificance among study groups in feed, labour, and total capital expenses and the total cost of production estimated in Section 6.2.2.3. As was observed with the total cost control ratios calculated for the 1995 data set, the low yielding group reported total economic costs of production to be greater than dairy enterprise revenue.

To expand on the cost of production estimations and efficiency measures discussed above, the competitive position of Alberta's dairy enterprises is assessed from a revenue standpoint by comparing the average economic profit imputed for each study group.

6.4 PROFITABILITY

In practice, profitability is the result of a farm's management decisions. It is directly related to an operator's success or failure in achieving an efficient, low cost of production enterprise. The average economic profit of farms under supply management is estimated for each study group for the 1996, 1995, and 1994 dairy years. As explained in Section 5.1.2, the economic profit of a farm results when values for family and operator labour and owner's equity are subtracted, along with all other costs of production, from the gross revenue of the dairy enterprise. It is important to note that milk prices used to impute farm economic profit varied slightly between dairy enterprises depending upon the value attached to the butterfat,

TABLE 6.24: Economic Efficiency: 1994 Cost Control Ratios According to Farm Milk Yield[a]

COST CONTROL RATIO	GROUP M1 Under 80 hl/cow	GROUP M2 80-90 hl/cow	GROUP M3 Over 90 hl/cow	F STATISTIC
Feed Cost	0.29	0.27	0.30	0.72
Labour Cost	0.27	0.24	0.21	1.72
Capital Cost	0.26	0.21	0.23	1.38
Total Cost	1.06	0.95	0.97	1.42

a * denotes statistical significance at a 95 percent confidence interval

protein, and other solids composition of farm milk under Multiple Component pricing.[26]

6.4.1 Estimated Supply Management Economic Profit: Herd Size Distribution of Data

Table 6.25 presents the economic profit estimated for each category of herd size when farms are paid 1996, 1995, and 1994 Canadian supply-managed milk prices. The significance of differences in annual economic profits among study groups is revealed by the F statistic. If a year's estimated economic profit was found to differ significantly among the categories of herd size, three additional analyses of variance were run to determine from which group or groups the detected variation was originating. A statistical summary of all analyses of variance conducted is provided in Appendix J.

Coinciding with the 1996 total economic cost of production estimates derived in Section 6.2.1.1, differences in the 1996 economic profit of study groups did not differ significantly. Thus, the absence of economies of size with respect to production costs impedes advantages of size from surfacing with respect to farm profitability.

Examination of the 1995 data set found a direct relationship to exist between average economic profit and farm herd size, reflecting the *inverse* relationship found between average total economic costs of production and herd size. The 1995 total cost advantage reported by the large herd size group (Group H3) allowed farms milking over 90 head to average a significantly higher return compared to the small and average size herd groups (Group H1 and Group H2). Specifically, Group H3 reported an average economic profit of $9.06 per hectolitre while Group H1 and Group H2 sustained a net loss of ($2.22) per hectolitre and ($1.44) per hectolitre respectively.

As was observed for the 1995 data set, the 1994 average economic profit estimated for each category of herd size was a direct reflection of the respective group's estimated total economic cost of production. For instance, the large herd size group which reported a significantly lower total production cost for 1994, were found to have a significantly higher 1994 economic profit compared to the small and average herd size groups. Average 1994 economic profits imputed for Groups H1, H2, and H3 are as follows: ($5.45) per hectolitre, $0.34 per hectolitre, and $9.57 per hectolitre.

6.4.1.1 Summary of economic profit derived according to farm herd size

The percentage change in annual economic profits for study Groups H1, H2, and H3 are summarized in Table 6.26. The F statistic from the single factor / one-way ANOVA performed to determine the significance of differences in profitability between years is included. Refer to Appendix J for a statistical summary of the ANOVA analysis.

The net income figures reviewed above reiterate the most overt condition of profitability: profit is based on the difference between a commodity's cost of production and its sale price. More specifically, an inverse relationship between economic profit and total operating expenditures has been established. Following the total economic cost of production

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[26] Average annual Canadian blended milk prices used to impute farm economic profit are as follows: 1996- $52.58/hl; 1995- $50.73/hl; 1994- $49.89/hl

TABLE 6.25: Average Economic Profit Estimated According to Farm Herd Size: 1994 - 1996 ($/hl)[a]

ECONOMIC PROFIT	GROUP H1 40 - 50 Dairy Cows	GROUP H2 50 - 70 Dairy Cows	GROUP H3 Over 90 Dairy Cows	F STATISTIC
1996	(0.93)	2.47	6.54	2.77
1995	(2.22)	(1.44)	9.06	7.17*
1994	(5.45)	0.34	9.57	8.86*

[a] * denotes statistical significance at a 95 percent confidence interval

TABLE 6.26 Changes in Average Economic Profit According to Farm Herd Size: 1994 - 1996 ($/hl)[a]

STUDY GROUP	1994	1995	% Change	F STAT 1994-95	1996	% Change	F STAT 1995-96	F STAT 1994-96
40 - 50 Cows	(5.45)	(2.22)	+ 59.27	0.48	(0.93)	+ 58.11	0.69	1.86
50 - 70 Cows	0.34	(1.44)	- 523.53	0.65	2.47	+ 271.53	2.98	1.32
Over 90 Cows	9.57	9.06	+ 5.33	0.03	6.54	- 27.81	0.92	1.43

[a] * denotes statistical significance at a 95 percent confidence interval

estimates stated in Section 6.2.1, no significant difference in estimated profit was identified among categories of herd size for the 1996 dairy year while in 1995 and 1994, the large herd size group reported significantly higher economic profits than the small and average herd size groups.

The profitability results discussed also exhibit how the economic profit of Alberta dairy farms is affected by domestic policy. Because of Canada's supply managed dairy industry, prices received are stable and variation in net return reflects the timing of policy changes: adjusting fluid milk prices to coincide with the rise or fall of dairy costs of production. Recall that the large herd size group (Group H3) reported a significant increase in its total operating expense between 1995 and 1996 and also between 1994 and 1996; however, no significant change in economic profit were reported by herds milking over 90 head for these two time periods. This finding supports the argument made by Jeffrey (1992) and Ross et al (1998) that Canadian dairy farmers are compensated for higher costs of production by higher milk prices. In light of this, a true indication of the competitive position of Alberta's dairy farms, on an international level, cannot be determined by assessing current economic profit. However, the comparison of low and high net returns across study groups can facilitate the examination of profitability in relation to farms' management and cost characteristics.

An ANOVA analysis was performed, across years, comparing the operational features and cost characteristics of farms reporting the top 5 percent of estimated economic profits and farms reporting the bottom 5 percent of estimated economic profits for each category of herd size. Refer to Appendix K for a statistical summary of each analysis of variance conducted.

The top 5 percent of the small herd size group's profitable farms realized a significantly lower user cost for farm machinery and equipment. The average herd size group reported no significant difference in the operational features or cost characteristics of farms possessing its top and bottom net return figures. The top 5 percent of profitable farms in the large herd size group disclosed a significantly higher milk yield per cow. Parallel to this, the quota holding, measured in both hectolitres and dollars, of the farms reporting Group H3's top net returns were also significantly higher. Finally, the family and operator labour costs of the large herd size group's top profiting farms were significantly lower than those incurred by the group's bottom 5 percent.

The results of how net return is statistically related to a farm's management and cost characteristics provide insight into factors underlying the conclusions made earlier in this thesis. First, recall from Section 6.1.1 and Section 6.3.1.1, there appeared to be no apparent relationship between farm herd size and average cow productivity. However, comparing farms reporting the low and high net returns across study groups, economies of yield was found to exist among the large herd size group. Support is therefore provided for the argument made by Barichello et al (1996) that lower production costs result not only from an increase in farm size, but also from an increase in yield per cow or some a combination of these two factors.

The fact that family and operator labour costs of farms milking over 90 head were significantly lower for operations reporting the group's highest profit levels reenforces the finding of Section 6.2.1 that properly managing labour costs is a key determinant in the overall cost competitiveness of large dairy herds in Alberta.

6.4.2 Estimated Supply Management Economic Profit: Milk Yield Distribution of Data

The estimates of economic profit for each category of milk yield, assuming 1996, 1995, and 1994 Canadian supply-managed milk prices are received by producers, are presented in Table 6.27. The F statistic indicated reveals the significance of differences in annual economic profit measures among study groups. Appendix L provides a statistical summary of each single factor / one-way ANOVA performed.

A direct relationship between average economic profit and milk production per cow was observed for the 1996 dairy year. Increasing with milk yield, net returns of dairy enterprises comprising Groups M1, M2, and M3 were estimated to be as follows: $0.90 per hectolitre, $4.51 per hectolitre, and $5.12 per hectolitre. Despite the fact that 1996 total economic cost of production estimated for the low and high yielding groups in Section 6.2.2.1 differed significantly, no significant difference in the 1996 economic profit of these two groups was found. This suggests that the price of milk received by the low yielding group provided compensation for the higher estimated total cost of production this group incurred. It can be argued that this compensation discourages low yielding farms from reducing total costs or increasing the production levels of their herds. This inference would support the argument that Canada's supply managed dairy industry promotes inefficiency and impedes growth. Further research into this finding is suggested.

Although the 1995 total economic cost of production estimated for the low yielding and high yielding groups in Section 6.2.2.2 differed significantly, no significant difference with respect to economic profit was observed between the two study groups. Therefore, as was inferred when observing 1996 profit figures, the higher economic costs of production estimated for the low yielding herd group were outweighed by the supply managed price of milk paid to producers.

No significant difference in the economic profit measures of the three groups of milk yield were observed in the 1994 data set. This finding reflects the non-significant differences in total economic production costs derived for the 1994 dairy year in Section 6.2.2.3.

6.4.2.1 Summary of economic profit derived according to farm milk yield

A summary of the percentage change in the annual economic profits estimated for each category of milk yield is presented in Table 6.28. To reveal the significance of each percentage change, the F statistic from the single factor / one-way ANOVA is also presented. A statistical background of the ANOVA results is provided in Appendix L.

Parallel to the total economic cost of production derived for each study group, no significant difference in annual economic profit or the percentage change in returns across years was identified for the low, average, and high yielding farm groups. From an examination of the operational features and cost characteristics of the farms reporting the lowest and highest profit figures, within each group, some generalizations may be made about the management environment generated by a specific grouping of milk yield. Specifically, an analysis of variance was conducted, across years, comparing operational

TABLE 6.27: Average Economic Profit Estimated According to Farm Milk Yield: 1994 - 1996 ($/hl)[a]

ECONOMIC PROFIT	GROUP M1 Under 80 hl/cow	GROUP M2 80 - 90 hl/cow	GROUP M3 Over 90 hl/cow	F STATISTIC
1996	0.90	4.51	5.12	2.35
1995	(2.69)	2.69	2.40	2.42
1994	(1.70)	2.64	1.75	1.55

a * denotes statistical significance at a 95 percent confidence interval

TABLE 6.28 Changes in Average Economic Profit According to Farm Milk Yield: 1994-1996 ($/hl)[a]

STUDY GROUP	1994	1995	% Change	F STAT 1994-95	1996	% Change	F STAT 1995-96	F STAT 1994-96
Under 80hl/cow	(1.70)	(2.69)	- 258.24	0.11	0.90	+ 133.46	1.61	0.80
80 -90 hl/cow	2.64	2.69	+ 1.89	0.00	4.51	+ 67.66	0.64	0.98
Over 90hl/cow	1.75	2.40	+ 37.14	0.05	5.12	+ 113.33	1.25	1.87

a * denotes statistical significance at a 95 percent confidence interval

features and production costs of the farms reporting each group's top 5 percent profit figures and bottom 5 percent net return measures. Appendix M provides the statistical background of the analysis of variance conducted.

The low yielding group's (Group M1) most financially successful farms were found to have significantly larger herd sizes compared to those farms sustaining a net loss. Corresponding to their larger herd sizes, farms achieving Group M1's top economic profits reported a significantly greater quota holding, in both hectolitres and dollars. Family labour expenses and the user cost of buildings and machinery and equipment were significantly lower for the low yielding group's most profitable farms.

The ANOVA results of the average yielding study group (Group M2) were very similar to those of the low yielding group. Again, farms reporting the group's top net returns had significantly larger milking herds. Significantly higher quota holdings, in terms of hectolitres and dollars, reflect these larger herd sizes. Group M2's most profitable farms reported significantly lower family and operator labour costs, and a significantly smaller user cost of machinery and equipment.

Unlike the low and average yielding groups, the high yielding group (Group M3) displayed no significant difference in herd size among farms realizing its top 5 percent and bottom 5 percent of economic profits. Breeding expenditures and family labour costs were significantly lower for Group M3's most profitable dairy operations.

The fact that farms reporting the greatest net returns in the low and average yielding groups were found to have significantly larger herd sizes reemphasises the existence of economies of size in Alberta's dairy industry, and the relationship between herd size and milk yield identified by Barichello et al (1996). Not only is it concluded that economies of size surfaces for farms milking over 90 head, but now it is also inferred that per unit costs of production will decrease when dairy enterprises averaging below 90 hectolitres of milk per cow increase their herd size. Because these significantly larger herds, achieving each study group's highest level of profitability, also reported significantly lower family labour costs, the link between increased herd size, and lower labour costs first identified in Section 6.2.1 is reconfirmed.

As was noted in Section 4.2 of the literature review, one must take caution in utilizing profitability as a means to predict Canada's cost competitiveness in an open market economy.

As discussed, due to producer price guarantees under the nation's supply management system, it is not recommended that net income be adopted as an indicator of the economic well-being of Canadian dairy producers when direct comparisons of current costs of production are made. However, as previously decided, in the event that a simulation of various international milk prices is carried out, which assumes supply management no longer defines the policy environment of the Canadian dairy sector, profitability can provide an appropriate estimate of a farm's financial position.

6.4.3 Cost Competitiveness at an International Level

Introducing the implications of globalization to Canada's fluid milk market, via variable fluid milk prices, the economic profit of Alberta dairy producers are re-estimated by substituting the 1996, 1995, and 1994 Canadian supply managed producer prices with the 1996, 1995, and 1994 United States, Mexico, and New Zealand domestic milk prices.[27] This substitution of select international milk prices facilitates an indirect comparison of the given nation's costs of production with those of Alberta dairy farmers. The selection of the listed countries is based on the respective nation's potential impact on Canada's dairy trade and domestic milk prices in the event of deregulation. Refer to Section 5.1.4 of this study for a more detailed explanation. Following the findings of Cox and Zhu (1997), the economic profit of surveyed farms was also re-evaluated after decreasing the 1996, 1995, and 1994 Canadian milk prices by 24 percent in order to simulate complete trade liberalization in the world dairy sector. As was previously stated, to reflect complete trade liberalization, federal milk subsidy payments and milk levies were subtracted from each farms' statement of income before running each price simulation.

6.4.3.1 Estimated economic profit at international prices: herd size distribution of data

The profitability of each category of herd size, assuming producers are paid the 1996, 1995, and 1994 United States, Mexico, New Zealand, and free trade prices of milk, is outlined in Table 6.29.[28] The F statistic of the single factor / one-way ANOVA performed to reveal the significance of profitability differences among the three study groups is presented. A statistical summary of each analysis of variance conducted is provided in Appendix N.

Assuming the annual economic costs of production estimated in Section 6.2.1 are incurred by producers, no category of herd size was successful in achieving an average net return when paid the stated international fluid milk prices. During 1996, the small herd size group (Group H1) reported a significantly higher net loss compared to the large herd size group (Group H3) at the United States, Mexico, and New Zealand prices of milk. This observation contrasts with the findings of Section 6.2.1.1 which showed no significant difference in the total cost of production imputed for each category of herd size. It also differs from the results of Section 6.4.1 which reported that, under supply management, there exists no significant difference in the economic profits of study groups. This contradiction provides support for an earlier suggestion that high cost producers are compensated under supply management by an inflated milk price. It proposes that, when facing international

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[27] International milk prices were obtained from: Dairy Farmers of Canada. (1999).

[28] The United States, Mexico and New Zealand prices utilized in this price simulation were converted from American dollars to Canadian dollars per hectolitre by multiplying the respective international price by the following Canada-US exchange rates (annual averages of monthly data from Bank of Canada, 1997):
1996- $1.3636 Canadian dollars per American dollar,
1995- $1.376 Canadian dollars per American dollar,
1994- $1.3659 Canadian dollars per American dollar.

TABLE 6.29: Economic Profit at International Prices According to Herd Size: 1994 - 1996 (Cdn. $/hl)[a,b]

NATIONAL PRICE (Cdn.$/hl)	GROUP H1 40 - 50 Dairy Cows	GROUP H2 50 - 70 Dairy Cows	GROUP H2 Over 90 Dairy Cows	F STATISTIC
1996				
US: 46.91	(8.21)	(4.65)	(1.29)	3.42*
Mexico: 41.99	(13.14)	(9.57)	(6.21)	3.42*
New Zealand: 28.51	(26.61)	(23.05)	(19.68)	3.42*
Free Trade: 39.96	(14.14)	(12.17)	(8.16)	2.91
1995				
US: 39.72	(13.13)	(13.39)	(3.00)	6.80*
Mexico: 31.42	(21.44)	(21.70)	(11.30)	6.80*
New Zealand: 26.22	(26.46)	(26.91)	(16.50)	6.80*
Free Trade: 38.56	(14.48)	(14.55)	(4.17)	6.74*
1994				
US: 40.24	(16.12)	(9.51)	(0.51)	8.89*
Mexico: 45.53	(12.83)	(6.22)	(2.79)	8.89*
New Zealand: 22.99	(33.37)	(26.77)	(17.76)	8.89*
Free Trade: 37.92	(17.59)	(12.37)	(2.87)	8.56*

a * denotes statistical significance at a 95 percent confidence interval
b free trade prices represent the respective year's average

competition, herds milking between 40 and 50 cows are significantly worse off than those farms milking over 50 head.

It is interesting to note that at the 1996 free trade price of milk, no significant difference in the economic profit reported by the three study groups was found. This finding reflects the fact that during 1996, the total economic cost of production imputed for each study group in Section 6.2.1 did not differ significantly. Because this trend was not observed for the 1995 and 1994 dairy years, it is suggested that this finding may be the result of the methodology employed to derive a simulated free trade price of milk. More specifically, because the free trade price is found by decreasing current milk sales by 24 percent, the 1996 supply managed milk price could possibly still be represented. Thus, the compensation provided to high cost producers described above surfaces, and no significant difference in the economic profit of study groups is found.

When producers received the 1995 international milk prices, the large herd size group reported a significantly lower net loss compared to the small and average herd size groups at each price. This finding corresponds to the 1995 economic costs of production imputed in Section 6.2.1.2 where the large herd size group were found to have a significantly lower total cost of production.

The results of 1994 mirrored those of 1995 as the large herd size group sustained a significantly lower net loss compared to the small and average herd size groups at each international milk price. This follows the large herd size group reporting a significantly lower total cost of production in Section 6.2.1.3.

Acknowledging the findings of Section 6.2.1 and Section 6.4.1.1 that labour costs are a key determinant in the overall cost competitiveness of dairy herds in Alberta, the profitability status of each category of herd size is reevaluated in a second price simulation where the 1996, 1995, and 1994 values of unpaid family labour and operator labour are set to zero. The imputed economic profit under this scenario and the percentage change in profit for Group H1, Group H2, and Group H3 are presented in Tables 6.30, 6.31, and 6.32 respectively. To reveal the significance of the percentage change in economic profit for each study group, the F statistic from the single factor / one-way ANOVA is also presented. A statistical background of the ANOVA results is provided in Appendix O.

When valuing family and operator labour at zero, a significant increase in annual economic profits, at each international milk price, was reported for the small and average herd size groups. However, a significant change in annual economic profit was not observed for the large herd size group when per unit family and operator labour costs were set to zero. This finding reenforces the conclusion made in Section 6.2.1 and Section 6.4.1.1 that proper management of unpaid labour costs is the key determinant in the cost competitive position of farms milking over 90 cows. It is also suggested that the family and operator labour costs of Alberta's largest dairy operations are already globally competitive, and therefore herds with over 90 head must look to other means to improve their cost competitiveness on an international level.

TABLE 6.30: Changes in Economic Profit of Group H1 Valuing Family and Operator Labour at Zero[a,b]

NATIONAL PRICE (Cdn. $/hl)	AVERAGE ECONOMIC PROFIT (Cdn. $/hl)	PERCENT CHANGE	F STATISTIC
1996			
US: 46.91	3.55	+ 143.24	10.95*
Mexico: 41.99	(1.37)	+ 89.57	10.95*
New Zealand: 28.51	(14.84)	+ 44.23	10.95*
Free Trade: 39.96	(2.37)	+ 83.24	11.26*
1995			
US: 39.72	1.72	+ 113.10	21.87*
Mexico: 31.42	(6.58)	+ 69.31	21.87*
New Zealand: 26.22	(11.78)	+ 55.48	21.87*
Free Trade: 38.56	0.37	+ 102.55	22.76*
1994			
US: 40.24	(2.08)	+ 87.10	6.72*
Mexico: 45.53	1.21	+ 109.43	6.72*
New Zealand: 22.99	(19.33)	+ 42.07	6.72*
Free Trade: 37.92	(3.55)	+ 79.82	7.30*

a * denotes statistical significance at a 95 percent confidence interval

b free trade prices represent the respective year's average

TABLE 6.31: Changes in Economic Profit of Group H2 Valuing Family and Operator Labour at Zero[a,b]

NATIONAL PRICE (Cdn. $/hl)	AVERAGE ECONOMIC PROFIT (Cdn. $/hl)	PERCENT CHANGE	F STATISTIC
1996			
US: 46.91	4.71	+ 201.29	27.68*
Mexico: 41.99	(0.22)	+ 97.70	27.68*
New Zealand: 28.51	(13.69)	+ 40.61	27.68*
Free Trade: 39.96	(2.81)	+ 76.91	27.97*
1995			
US: 39.72	(1.67)	+ 87.53	17.20*
Mexico: 31.42	(9.97)	+ 54.06	17.20*
New Zealand: 26.22	(15.17)	+ 43.63	17.20*
Free Trade: 38.56	(2.82)	+ 80.62	18.17*
1994			
US: 40.24	(2.31)	+ 75.71	44.27*
Mexico: 45.53	5.60	+ 190.03	44.27*
New Zealand: 22.99	(14.94)	+ 44.19	44.27*
Free Trade: 37.92	(0.54)	+ 95.63	45.16*

a * denotes statistical significance at a 95 percent confidence interval

b free trade prices represent the respective year's average

TABLE 6.32: Changes in Economic Profit of Group H3 Valuing Family and Operator Labour at Zero[a,b]

NATIONAL PRICE (Cdn. $/hl)	AVERAGE ECONOMIC PROFIT (Cdn. $/hl)	PERCENT CHANGE	F STATISTIC
1996			
US: 46.91	2.43	+ 288.37	3.54
Mexico: 41.99	(2.49)	+ 59.90	3.54
New Zealand: 28.51	(15.96)	+ 18.90	3.54
Free Trade: 39.96	(4.44)	+ 45.59	3.96
1995			
US: 39.72	1.67	+ 155.67	2.92
Mexico: 31.42	(6.63)	+ 41.33	2.92
New Zealand: 26.22	(11.84)	+ 28.24	2.92
Free Trade: 38.56	0.66	+ 115.83	2.55
1994			
US: 40.24	4.07	+ 898.04	3.05
Mexico: 45.53	7.36	+ 363.80	3.05
New Zealand: 22.99	(13.18)	+ 25.79	3.05
Free Trade: 37.92	1.70	+ 159.23	3.02

a * denotes statistical significance at a 95 percent confidence interval
b free trade prices represent the respective year's average

6.4.3.2 Estimated economic profit at international prices: milk yield distribution of data

Table 6.33 reveals the estimated economic profit for each category of farm milk yield assuming farmers receive the 1996, 1995, and 1994 United States, Mexico, New Zealand, and free trade prices of milk.[29] The significance of differences in profitability between the three study groups is identified by the F statistic of the single factor / one-way ANOVA performed. Refer to Appendix P for a statistical summary of the ANOVA results.

When incurring the annual economic costs of production reported in Section 6.2.2, not one category of milk yield was able to generate a positive net return when receiving the 1996, 1995, and 1994 Unite States, Mexico, New Zealand, or free trade prices of milk. During 1996 and 1995, the low yielding farm group (Group M1) reported a significantly greater net loss compared to the average and high yielding groups (Groups M2 and M3) at the United States, Mexico, and New Zealand milk prices. This finding contrasts with the 1996 and 1995 supply managed economic profits estimated in Section 6.4.2 where no significant difference in profit was observed between the three study groups. However, a correlation can be made between this observation and Group M1 reporting a significantly higher total cost of production compared Group M3 during 1996 and 1995. This illustrates the impact of economies of yield in an international marketplace.

In contrast to the results reported for the 1996 and 1995 dairy years, at 1994 economic costs of production, the imputed economic profit for each category of milk yield did not differ significantly at the United States, Mexico or New Zealand milk prices. This finding reflects 1994 economic production costs estimated in Section 6.2.2.3 which also displayed no significant difference between study groups.

The economic profit estimated for each group of milk yield, assuming free trade in the dairy sector, did not differ significantly. This implies that under free trade, profitability and milk yield are independent of each other.

To investigate a possible relationship between labour costs, cow productivity, and farm competitiveness at the international level, the economic profit of each group of farm milk yield is estimated a second time with unpaid family labour and operator labour valued at zero. Annual changes in profitability levels for each category are displayed in Tables 6.34, 6.35, and 6.36. The F statistic from the single factor / one-way ANOVA performed to reveal the significance of the percentage change in profitability for each study group is also presented. Refer to Appendix Q for a statistical summary of the ANOVA results

Re-estimating profitability when valuing family and operator labour at zero saw annual net returns increase for all three categories of milk yield at each international price. This finding suggests that decreasing labour costs in order to improve cost competitiveness on an international level is independent of cow productivity.

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[29] Milk prices of the United States, Mexico, and New Zealand were converted from American dollars to Canadian dollars per hectolitre using the previously stated Canada-US exchange rates.

TABLE 33: Economic Profit at International Prices According to Milk Yield: 1994 - 1996 (Cdn. $/hl)[a,b]

NATIONAL PRICE ($/hl)	GROUP M1 Under 80 hl/cow	GROUP M2 80 -90 hl/cow	GROUP M2 Over 90 hl/cow	F STATISTIC
1996				
US: 46.91	(8.55)	(3.53)	(1.10)	6.65*
Mexico: 41.99	(13.47)	(8.45)	(6.02)	6.65*
New Zealand: 28.51	(26.95)	(21.92)	(19.50)	6.65*
Free Trade: 40.02	(14.17)	(10.14)	(9.50)	2.84
1995				
US: 39.72	(14.95)	(9.09)	(8.62)	3.37*
Mexico: 31.42	(23.26)	(17.40)	(19.92)	3.37*
New Zealand: 26.22	(28.46)	(22.60)	(22.12)	3.37*
Free Trade: 38.74	(15.41)	(10.09)	(10.43)	2.44
1994				
US: 40.24	(12.33)	(7.14)	(7.10)	2.63
Mexico: 45.53	(9.04)	(3.85)	(3.81)	2.63
New Zealand: 22.99	(29.58)	(24.39)	(24.35)	2.63
Free Trade: 37.74	(14.05)	(9.72)	(10.74)	1.52

a * denotes statistical significance at a 95 percent confidence interval

b free trade prices represent the respective year's average

TABLE 6.34: Changes in Economic Profit of Group M1 Valuing Family and Operator Labour at Zero[a,b]

NATIONAL PRICE (Cdn. $/hl)	AVERAGE ECONOMIC PROFIT (Cdn. $/hl)	PERCENT CHANGE	F STATISTIC
1996			
US: 46.91	1.74	+ 120.35	20.45*
Mexico: 41.99	(3.19)	+ 76.32	20.45*
New Zealand: 28.51	(16.66)	+ 38.18	20.45*
Free Trade: 40.02	(3.88)	+ 72.62	19.32*
1995			
US: 39.72	(2.51)	+ 83.21	24.31*
Mexico: 31.42	(10.82)	+ 53.48	24.31*
New Zealand: 26.22	(16.02)	+ 43.71	24.31*
Free Trade: 38.74	(2.97)	+ 80.73	22.82*
1994			
US: 40.24	(1.30)	+ 89.46	17.45*
Mexico: 45.53	1.99	+ 122.01	17.45*
New Zealand: 22.99	(18.55)	+ 37.29	17.45*
Free Trade: 37.74	(3.02)	+ 78.51	18.59*

a * denotes statistical significance at a 95 percent confidence interval
b free trade prices represent the respective year's average

TABLE 6.35: Changes in Economic Profit of Group M2 Valuing Family and Operator Labour at Zero[a,b]

NATIONAL PRICE (Cdn. $/hl)	AVERAGE ECONOMIC PROFIT (Cdn. $/hl)	PERCENT CHANGE	F STATISTIC
1996			
US: 46.91	4.06	+ 215.01	19.13*
Mexico: 41.99	(0.87)	+ 89.70	19.13*
New Zealand: 28.51	(14.34)	+ 34.58	19.13*
Free Trade: 40.02	(2.55)	+ 74.85	19.25*
1995			
US: 39.72	0.71	+ 107.81	18.56*
Mexico: 31.42	(7.60)	+ 56.32	18.56*
New Zealand: 26.22	(12.80)	+ 43.36	18.56*
Free Trade: 38.74	(0.29)	+ 97.13	18.70*
1994			
US: 40.24	4.51	+ 163.17	43.11*
Mexico: 45.53	7.81	+ 302.86	43.11*
New Zealand: 22.99	(12.74)	+ 47.77	43.11*
Free Trade: 37.74	1.94	+ 119.96	41.45*

a * denotes statistical significance at a 95 percent confidence interval

b free trade prices represent the respective year's average

TABLE 6.36: Changes in Economic Profit of Group M3 Valuing Family and Operator Labour at Zero[a,b]

NATIONAL PRICE (Cdn. $/hl)	AVERAGE ECONOMIC PROFIT (Cdn. $/hl)	PERCENT CHANGE	F STATISTIC
1996			
US: 46.91	6.71	+ 710.00	16.14*
Mexico: 41.99	1.79	+ 129.73	16.14*
New Zealand: 28.51	(11.68)	+ 40.10	16.14*
Free Trade: 40.02	(1.69)	+ 82.21	15.50*
1995			
US: 39.72	0.96	+ 111.14	10.46*
Mexico: 31.42	(7.35)	+ 63.10	10.46*
New Zealand: 26.22	(12.55)	+ 43.26	10.46*
Free Trade: 38.74	(0.86)	+ 91.75	10.72*
1994			
US: 40.24	2.08	+ 129.30	10.80*
Mexico: 45.53	5.37	+ 240.94	10.80*
New Zealand: 22.99	(15.17)	+ 37.70	10.80*
Free Trade: 37.74	(1.56)	+ 85.47	11.42*

a * denotes statistical significance at a 95 percent confidence interval

b free trade prices represent the respective year's average

6.4.4 Correlation of Economic Profit and Farm Characteristics at International Prices

To indicate which operational features and production costs are more strongly associated with farms' level of profitability at each international milk price, a correlation analysis was conducted. Because the relationship between profitability and size and profitability and yield has been established, when calculating annual correlation coefficients, farms were examined as a single group rather than being divided into categories of herd size and milk yield. Results are presented below in Table 6.37, Table 6.38, Table 6.39, and Table 6.40.

Correlation coefficients calculated to reveal the association between farm economic profit and the stated farm variables were found to be consistent at the United States, Mexico, New Zealand, and free trade milk prices. Total costs of production per hectolitre reported the strongest association with farm economic profit for each year examined and for each international price employed. The negative correlation coefficient calculated for economic profit and total production costs indicates an inverse relationship: as operating expenditures increase, economic profit will decrease.

In 1996, at each simulated milk price, total feed costs moved ahead of family labour to have the second greatest association with farm economic profit. This finding is the result of a significant increase in 1996 feed costs for farms over 1995 and 1994 feed expenses.[30] Also in 1996, hired labour costs and operator costs were found to decrease in their relative importance to farm economic profit. Because hired labour and operator labour costs were not found to differ significantly between 1996 and 1995 or 1996 and 1994, the lessened association of these two production costs have with economic profit at each simulated milk price is a reflection of the increased feed expense reported for the 1996 dairy year.[31]

Examination of the imputed correlation coefficients suggests that in order for Alberta dairy producers to improve their level of economic profit at variable milk prices they must decrease their total cost of production. More specifically, their pursuit to decrease total costs should begin by controlling feed expenses and family labour costs. Correlation coefficients calculated for herd size and milk yield per cow did not vary greatly. Because a positive correlation was found between economic profit and these two variables, a farm could potentially increase its profitability, at the international level, by increasing both its total number of dairy cows and milk production per cow. The impact of economies of size and economies of yield on the cost competitiveness of Alberta's dairy producers is thus once again confirm.

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[30] Refer to Appendix R for a statistical summary of the ANOVA conducted to compare the significance of differences in annual feed costs.

[31] Appendix R provides a statistical summary of the ANOVA conducted to compare the significance of differences in annual hired labour and operator labour costs.

TABLE 6.37: Correlation Coefficient of Stated Variable & Economic Profit at US Milk Price

VARIABLE	1996 US Price: 46.91 Cdn.$/hl	1995 US Price: 39.72 Cdn.$/hl	1994 US Price: 40.24 Cdn.$/hl
Herd Size	0.30	0.46	0.49
Milk Yield (hl/cow)	0.39	0.29	0.29
Total Feed Cost/hl	-0.57	-0.35	-0.29
Hired Labour Cost/hl	0.26	-0.54	-0.42
Family Labour Cost/hl	-0.53	-0.61	-0.56
Operator Labour Cost/hl	-0.28	-0.60	-0.53
Total COP/hl	-0.93	-0.92	-0.90

TABLE 6.38: Correlation Coefficient of Stated Variable & Economic Profit at Mexico Milk Price

VARIABLE	1996 Mexico Price: 41.99 Cdn.$/hl	1995 Mexico Price: 31.42 Cdn.$/hl	1994 Mexico Price: 43.53 Cdn.$/hl
Herd Size	0.30	0.46	0.49
Milk Yield (hl/cow)	0.39	0.30	0.29
Total Feed Cost/hl	-0.57	-0.35	-0.29
Hired Labour Cost/hl	0.26	-0.53	-0.42
Family Labour Cost/hl	-0.53	-0.61	-0.56
Operator Labour Cost/hl	-0.28	-0.60	-0.53
Total COP/hl	-0.92	-0.92	-0.90

TABLE 6.39: Correlation Coefficient of Stated Variable & Economic Profit at New Zealand Milk Price

VARIABLE	1996 New Zealand Price: 28.51 Cdn.$/hl	1995 New Zealand Price: 26.22 Cdn.$/hl	1994 New Zealand Price: 22.99 Cdn.$/hl
Herd Size	0.30	0.46	0.49
Milk Yield (hl/cow)	0.39	0.30	0.29
Total Feed Cost/hl	-0.57	-0.35	-0.29
Hired Labour Cost/hl	0.26	-0.53	-0.42
Family Labour Cost/hl	-0.53	-0.61	-0.56
Operator Labour Cost/hl	-0.28	-0.60	-0.53
Total COP/hl	-0.93	-0.92	-0.90

TABLE 6.40: Correlation Coefficient of Stated Variable & Economic Profit at Free Trade Milk Price[a]

VARIABLE	1996	1995	1994
Herd Size	0.32	0.47	0.46
Milk Yield (hl/cow)	0.26	0.22	0.24
Total Feed Cost/hl	-0.59	-0.35	-0.30
Hired Labour Cost/hl	0.28	-0.51	-0.42
Family Labour Cost/hl	-0.53	-0.62	-0.55
Operator Labour Cost/hl	-0.26	-0.61	-0.53
Total COP/hl	-0.90	-0.91	-0.89

a average annual free trade milk prices used to impute farm economic profit are as follows: 1996- $39.96/hl; 1995- $38.56/hl; 1994- $37.92/hl

CHAPTER 7: SUMMARY and CONCLUSIONS

7.1 SUMMARY

With the high degree of government involvement in Canada's dairy industry, determining the fundamental competitiveness of dairy farmers requires the analysis of trends in the determinants of competitiveness. Because of a) the uniform marketing of milk by dairy producers, resultant of Canada's supply management system, b) the homogeneity of milk production at the farm level, and c) the inelastic nature of domestic milk demand, the most appropriate determinant to evaluate is cost of production. Thus, the working definition of competitiveness employed by this study was based on the cost competitiveness of Alberta dairy producers. Specifically, the dairy farm or group of dairy farms achieving the lowest per unit cost of production was identified as being the most competitive.

To investigate the possibility of economies of size and economies of yield existing within the Alberta dairy industry, the farm-level cost data employed were divided into categories of herd size and milk production per cow. To quantify the unpaid family labour component of farms and to account for the opportunity cost of producers investing in the province's dairy sector, the economic costs associated with milk production were estimated. To explain differences in production costs across herd size and milk yield groupings, the physical and economic efficiency of producers was derived. The impact of varying milk prices on Alberta's dairy farms was assessed by imputing the economic profit of farms under select international milk price simulations.

7.2 CONCLUSIONS

With the World Trade Organization (WTO) currently formulating an agenda for a new round of global trade negotiations, the likelihood of increased competition in the Canadian dairy industry is probable. Changes in Canada's supply management dairy system would undoubtedly have implications at the farm level. Consequently, there may be a greater need for producers to be concerned with their *competitiveness*. This study focused on the competitiveness of Alberta dairy producers. The major conclusions found are outlined below.

(1) Economies of size were observed for the 1994 and 1995 dairy years. Specifically, total operating expenses were significantly lower for the large herd size group, farms milking over 90 cows. This economies of size is attributed to lower family and operator labour costs reported by farms milking over 90 head.

(2) Economies of yield were observed for the 1995 and 1996 dairy years. Specifically, average total COP per hectolitre of milk decreased significantly when moving from an average production level below 80 hectolitres of milk per cow to an average milk yield over 90 hectolitres per cow. This total cost disadvantage reported by the low yielding farm group is credited to a significantly higher user cost of machinery and equipment, and a higher user cost of cattle.

(3) Labour costs and user costs of capital were identified as having the most significant impact on the total costs of production of Alberta dairy producers. Feed costs represent a significant potential savings for farmers.

(4) A link between increased herd size, labour productivity, and lower total labour costs was identified. It is suggested that economies of size facilitates the adoption of labour-saving technology by farms milking over 90 head and in return lowers labour expenses.

(5) The estimated labour productivity of all herd size categories increased their labour productivity between 1994 and 1996.

(6) Labour productivity was not influenced by milk yield per cow.

(7) A relationship between herd size and milk yield was observed. Specifically, profit levels within the large herd size group rose when milk yield per cow increased. Economic profit also increased within the small and average milk yield groups when herd size increased.

(8) At 1994, 1995, and 1996 economic costs of production, Alberta dairy producers are not cost competitive at the international level.

(9) To improve economic profit at the international level, farms must decrease total costs of production by decreasing feed and family labour costs.

7.3 LIMITATIONS AND SUGGESTED FURTHER RESEARCH

The competitiveness of a particular sector is only as strong as the weakest link in its "value system" of related and supporting industries. Thus, to accurately predict the competitive position of Alberta's dairy producers in a global marketplace, a cost analysis incorporating the processing, distribution and marketing sectors is imperative.

This study employed a static methodology where the cost competitiveness of Alberta dairy farmers was examined in the short run. A more concise prediction of the fate of Alberta dairy producers in a free trade scenario could have been achieved by constructing a model simulating the long run where supply responses are observed and both production and prices may adjust in response to changes in demand and supply. This study was conducted using the most recent cost data available for Alberta dairy farms, the examination of current cost data would address the concern that the province's largest herds may be losing their cost competitive position.

The annual data sets examined contained production costs only for the dairy enterprise of each farm. Having cost data from all business ventures of each farm would answer questions on the role of diversification on Alberta's large-scale dairy operations.

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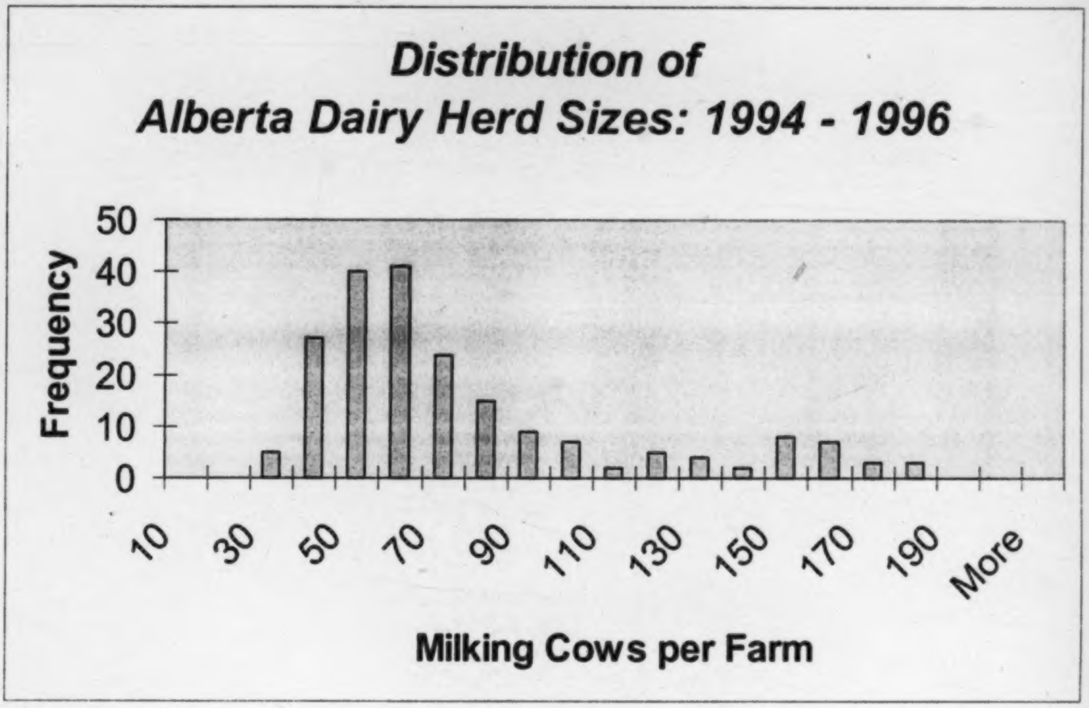
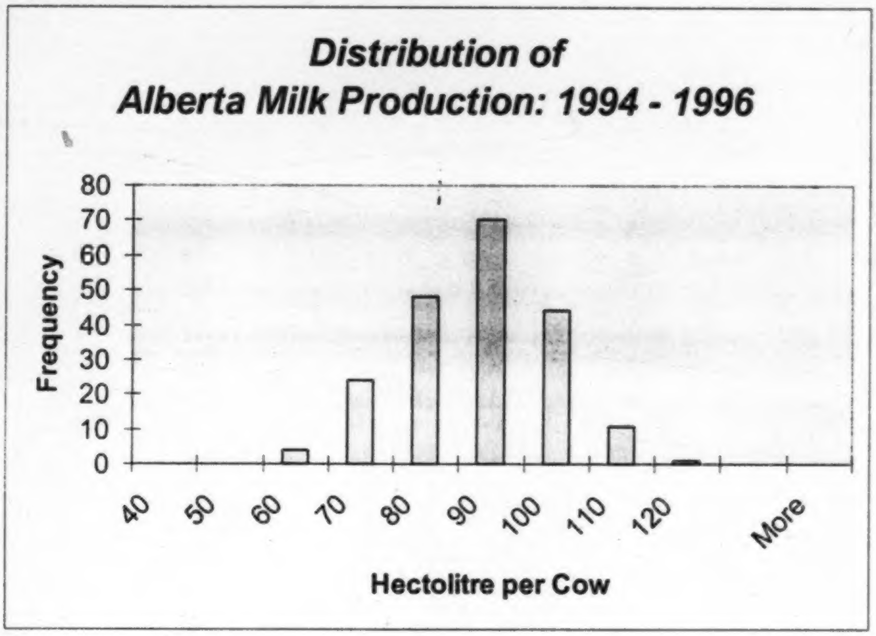
APPENDICES

APPENDIX A

Histograms



Distribution of Alberta Dairy Herd Sizes: 1994 - 1996


Distribution of
Alberta Milk Production: 1994 - 1996
Frequency
80
70
60
50
40
30
20
10
0
40
50
60
70
80
90
100
110
120
More
Hectolitre per Cow

APPENDIX B

ANOVA Summary for Farm Data Characteristics

Herd Size Distribution of Data

TABLE 1: ANOVA Summary for 1996 Average Number of Dairy Cows: Groups H1, H2, and H3

Source of Variation	**SS**	**df**	**MS**	**F**	**P-Value**	**F crit**
Between Groups	58686.77	2	29343.39	**124.6612***	7.49E-19	3.20928
Within Groups	10356.94	44	235.3851			
Total	69043.72	46				

TABLE 2: ANOVA Summary for 1996 Average Number of Dairy Cows: Groups H1 and H2

Source of Variation	**SS**	**df**	**MS**	**F**	**P-Value**	**F crit**
Between Groups	1643.34	1	1643.34	**81.44172***	3.5E-10	4.159617
Within Groups	625.5215	31	20.17811			
Total	2268.862	32				

TABLE 3: ANOVA Summary for 1996 Average Number of Dairy Cows: Groups H1 and H3

Source of Variation	**SS**	**df**	**MS**	**F**	**P-Value**	**F crit**
Between Groups	45726.93	1	45726.93	**107.1573***	3.97E-10	4.279343
Within Groups	9814.726	23	426.7272			
Total	55541.65	24				

TABLE 4: ANOVA Summary for 1996 Average Number of Dairy Cows: Groups H2 and H3

Source of Variation	**SS**	**df**	**MS**	**F**	**P-Value**	**F crit**
Between Groups	43357.64	1	43357.64	**143.4895***	9.45E-14	4.130015
Within Groups	10273.64	34	302.1659			
Total	53631.28	35				

TABLE 5: ANOVA Summary for 1996 Average Number of Years Farming: Groups H1, H2, and H3

Source of Variation	**SS**	**df**	**MS**	**F**	**P-Value**	**F crit**
Between Groups	439.8022	2	219.9011	2.050523	0.140786	3.20928
Within Groups	4718.623	44	107.2414			
Total	5158.426	46				

TABLE 6: ANOVA Summary for 1996 Average Percent Dairy Income: Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2348.25	2	1174.125	**4.354412***	0.018816	3.20928
Within Groups	11864.18	44	269.6403			
Total	14212.43	46				

TABLE 7: ANOVA Summary for 1996 Average Percent Dairy Income: Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	128.2424	1	128.2424	0.777103	0.384813	4.159617
Within Groups	5115.818	31	165.0264			
Total	5244.061	32				

TABLE 8: ANOVA Summary for 1996 Average Percent Dairy Income: Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	922..9156	1	922.9156	2.076791	0.163031	4.279343
Within Groups	10221.08	23	444.395			
Total	11144	24				

TABLE 9: ANOVA Summary for 1996 Average Percent Dairy Income: Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2307.302	1	2307.302	**9.348597***	0.004328	4.130015
Within Groups	8391.448	34	246.8073			
Total	10698.75	35				

TABLE 10: ANOVA Summary for 1996 Average Total Annual Milk Production (hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	3.75E+08	2	1.87E+08	**89.86***	2.9E-16	3.21
Within Groups	91776812	44	2085837			
Total	4.67E+08	46				

TABLE 11: ANOVA Summary for 1996 Average Annual Milk Production(hl): Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	16211056	1	16211056	**32.33485***	3E-06	4.159617
Within Groups	15541830	31	501349.4			
Total	31752886	32				

TABLE 12: ANOVA Summary for 1996 Average Annual Milk Production(hl): Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	3.05E+08	1	3.05E+08	**89.15034***	2.23E-09	4.279343
Within Groups	78580781	23	3416556			
Total	3.83E+08	24				

TABLE 13: ANOVA Summary for 1996 Average Annual Milk Production (hl): Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2.63E+08	1	2.63E+08	**100.0087***	1.17E-11	4.130015
Within Groups	89431013	34				
Total	3.52E+08	35				

TABLE 14: ANOVA Summary for 1996 Average Milk Yield Per Cow (hl/cow): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	258.5456	2	129.2728	1.564514	0.220603	3.20928
Within Groups	3635.637	44	82.62811			
Total	3894.183	46				

TABLE 15: ANOVA Summary for 1996 Average Quota Holding (hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2.02E+08	2	1.01E+08	**39.74056***	1.38E-10	3.20928
Within Groups	1.12E+08	44	2537127			
Total	3.13E+08	46				

TABLE 16: ANOVA Summary for 1996 Average Quota Holding (hl): Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2704457	1	2704457	3.839191	0.059113	4.159617
Within Groups	21837454	31	704434			
Total	24541910	32				

TABLE 17: ANOVA Summary for1996 Average Quota Holding (hl): Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.48E+08	1	1.48E+08	**36.65807***	3.56E-06	4.279343
Within Groups	92935804	23	4040687			
Total	2.41E+08	24				

TABLE 18: ANOVA Summary for 1996 Average Quota Holding (hl): Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.58E+08	1	1.58E+08	**49.49151***	4.03E-08	4.130015
Within Groups	1.08E+08	34	3190999			
Total	2.66E+08	35				

TABLE 19: ANOVA Summary for 1996 Average Percent Over Quota Milk Production: Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	660.4783	2	330.2392	1.239537	0.299429	3.20928
Within Groups	11722.54	44	266.4213			
Total	12383.01	46				

TABLE 20: ANOVA Summary for 1996 Average Quota Holding ($): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	6.66E+11	2	3.33E+11	**38.36587***	2.27E-10	3.20928
Within Groups	3.82E+11	44	8.68E+09			
Total	1.05E+12	46				

TABLE 21: ANOVA Summary for 1996 Average Quota Holding ($): Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	8.36E+09	1	8.36E+09	3.539503	0.069344	4.159617
Within Groups	7.32E+10	31	2.36E+09			
Total	8.15E+10	32				

TABLE 22: ANOVA Summary for 1996 Average Quota Holding ($) Between Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	4.87E+11	1	4.87E+11	**34.995***	4.97E-06	4.279343
Within Groups	3.2E+11	23	1.39E+10			
Total	8.07E+11	24				

TABLE 23: ANOVA Summary for 1996 Average Quota Holding ($): Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	5.24E+11	1	5.24E+11	**48.04482***	5.46E+08	4.130015
Within Groups	3.71E+11	34	1.09E+10			
Total	8.94E+11	35				

TABLE 24: ANOVA Summary for 1995 Average Number of Dairy Cows: Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	68837.887	2	34418.94	**152.0163***	9.61E-21	3.20432
Within Groups	10188.73	45	226.4126			
Total	79026.60	47				

TABLE 25: ANOVA Summary for 1995 Average Number of Dairy Cows: Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1741.293	1	1741.93	**66.50556***	2.58E-09	4.149086
Within Groups	837.8456	32	26.18267			
Total	2579.139	33				

TABLE 26: ANOVA Summary for 1995 Average Number of Dairy Cows: Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	57724.59	1	57724.59	**157.867***	1.5E-12	4.2252
Within Groups	9506.987	26	365.6534			
Total	67231.57	27				

TABLE 27: ANOVA Summary for 1995 Average Number of Dairy Cows: Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	47903.69	1	47903.69	**152.7934***	1E-13	4.149086
Within Groups	10032.62	32	313.5194			
Total	57936.31	33				

TABLE 28: ANOVA Summary for 1995 Average Number of Years Farming: Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	184.2357	2	92.11786	0.790822	0.459672	3.20432
Within Groups	5241.764	45	116.4837			
Total	5426	47				

TABLE 29: ANOVA Summary for 1995 Average Annual Milk Production (hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	4.48E+08	2	2.24E+08	**120.3815***	8.65E+08	3.20432
Within Groups	83745027	45	1861001			
Total	5.32E+08	47				

TABLE 30: ANOVA Summary for 1995 Average Annual Milk Production (hl): Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	13532976	1	13532976	**21.87216***	5.07E-05	4.149086
Within Groups	19799378	32	618730.6			
Total	33332354	33				

TABLE 31: ANOVA Summary for 1995 Average Annual Milk Production (hl): Groups H1and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	3.81E+08	1	3.81E+08	**139.8576***	5.79E-12	4.2252
Within Groups	70752385	26	2721246			
Total	4.51E+08	27				

TABLE 32: ANOVA Summary for 1995 Average Annual Milk Production (hl): Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	3.06E+08	1	3.06E+08	**127.1037***	1.11E-12	4.149086
Within Groups	76938290	32	2404322			
Total	3.83E+08	33				

TABLE 33: ANOVA Summary for 1995 Average Milk Yield Per Cow (hl/cow): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	32.64385	2	16.32193	0.124488	0.883252	3.20432
Within Groups	5900.051	45	131.1123			
Total	5932.695	47				

TABLE 34: ANOVA Summary for 1995 Average Quota Holding (hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2.2E+08	2	1.1E+08	**35.67325***	5.22E-10	3.20432
Within Groups	1.39E+08	45	3079599			
Total	3.58E+08	47				

TABLE 35: ANOVA Summary for 1995 Average Quota Holding (hl): Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	5788885	1	5788885	**7.795462***	0.008764	4.149086
Within Groups	23763097	32	742596.8			
Total	29551982	33				

TABLE 36: ANOVA Summary for 1995 Average Quota Holding (hl) Between Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.85E+08	1	1.85E+08	**39.94675***	1.08E-06	4.2252
Within Groups	1.2E+08	26	4625687			
Total	3.05E+08	27				

TABLE 37: ANOVA Summary for 1995 Average Quota Holding (hl): Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.52E+08	1	1.52E+08	**36.59004***	9.42E-07	4.149086
Within Groups	1.33E+08	32	4160406			
Total	2.85E+08	33				

TABLE 38: ANOVA Summary for 1995 Average Percent Over Quota Milk Production: Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	58.33321	2	29.16661	0.080756	0.922553	3.20432
Within Groups	16252.73	45	361.1717			
Total	16311.06	47				

TABLE 39: ANOVA Summary for 1995 Average Quota Holding ($): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	6.37E+11	2	3.19E+11	**35.08247***	6.57E-10	3.20432
Within Groups	4.09E+11	45	9.08E+09			
Total	1.05E+12	47				

TABLE 40: ANOVA Summary for 1995 Average Quota Holding ($): Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.71E+10	1	1.71E+10	**8.121226***	0.007592	4.149086
Within Groups	6.75E+10	32	2.11E+09			
Total	8.46E+10	33				

TABLE 41: ANOVA Summary for 1995 Average Quota Holding ($): Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	5.37E+11	1	5.37E+11	**39.0731***	1.29E-06	4.2252
Within Groups	3.57E+11	26	1.37E+10			
Total	8.94E+11	27				

TABLE 42: ANOVA Summary for 1995 Average Quota Holding ($): Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	4.41E+11	1	4.41E+11	**35.88876***	1.11E-06	4.149086
Within Groups	3.93E+11	32	1.23E+10			
Total	8.33E+11	33				

TABLE 43: ANOVA Summary for 1994 Average Number of Dairy Cows: Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	66105.01	2	33052.5	**192.3054***	1.21E-23	3.190721
Within Groups	8250.002	48	171.875			
Total	74355.01	50				

TABLE 44: ANOVA Summary for 1994 Average Number of Dairy Cows: Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1465.569	1	1465.569	**86.14158***	4.38E-11	4.113161
Within Groups	612.4857	36	17.01349			
Total	2078.055	37				

TABLE 45: ANOVA Summary for 1994 Average Number of Dairy Cows: Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	55636.6	1	55636.6	**186.2147***	2.31E-13	4.2252
Within Groups	7768.192	26	298.7766			
Total	63404.79	27				

TABLE 46: ANOVA Summary for 1994 Average Number of Dairy Cows: Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	48828.86	1	48828.86	**204.4728***	6.07E-16	4.130015
Within Groups	8119.326	34	238.8037			
Total	56948.18	35				

TABLE 47: ANOVA Summary for 1994 Average Number of Years Farming: Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	26.8399	2	13.41995	0.120745	0.886528	3.190721
Within Groups	5334.846	48	111.1426			
Total	5361.686	50				

TABLE 48: ANOVA Summary for 1994 Average Annual Milk Production (hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	4.54E+08	2	2.27E+08	**160.8473***	5.27E-22	3.190721
Within Groups	67720864	48	141051			
Total	5.22E+08	50				

TABLE 49: ANOVA Summary for 1994 Average Annual Milk Production (hl): Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	18329769	1	18329769	**34.00626***	1.17E-06	4.113161
Within Groups	19404419	36	539011.6			
Total	37734188	37				

TABLE 50: ANOVA Summary for 1994 Average Annual Milk Production (hl): Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	3.99E+08	1	3.99E+08	**192.03***	1.62E-13	4.2252
Within Groups	53970934	26	2075805			
Total	4.53E+08	27				

TABLE 51: ANOVA Summary for 1994 Average Annual Milk Production (hl): Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	3.14E+08	1	3.14E+08	**171.7846***	7.53E-15	4.130015
Within Groups	62066375	34	1825482			
Total	3.76E+08	35				

TABLE 52: ANOVA Summary for 1994 Average Milk Yield Per Cow (hl/cow): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	558.8698	2	279.4349	2.161677	0.126211	3.190721
Within Groups	6204.846	48	129.2676			
Total	6763.715	50				

TABLE 53: ANOVA Summary for 1994 Average Quota Holding (hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2.23E+08	2	1.11E+08	**41.07596***	4.01E-11	3.190721
Within Groups	1.3E+08	48	2711050			
Total	3.53E+08	50				

TABLE 54: ANOVA Summary for 1994 Average Quota Holding (hl): Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2470246	1	2470246	2.979663	0.092891	4.113161
Within Groups	29845273	36	829035.4			
Total	32315520	37				

TABLE 55: ANOVA Summary for 1994 Average Quota Holding (hl): Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.8E+08	1	1.8E+08	**44.80713***	4.21E-07	4.2252
Within Groups	1.04E+08	26	4017623			
Total	2.84E+08	27				

TABLE 56: ANOVA Summary for 1994 Average Quota Holding (hl): Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.73E+08	1	1.73E+08	**46.67015***	7.32E-08	4.130015
Within Groups	1.26E+08	34	3704628			
Total	2.99E+08	35				

TABLE 57: ANOVA Summary for 1994 Average Percent Over Quota Milk Production: Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	982.5068	2	491.2534	1.309926	0.279312	3.190721
Within Groups	18001.15	48	375.0239			
Total	18983.65	50				

TABLE 58: ANOVA Summary for 1994 Average Quota Holding ($): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	6.28E+11	2	3.14E+11	**39.45726***	7.34E-11	3.190721
Within Groups	3.82E+11	48	7.96E+09			
Total	1.01E+12	50				

TABLE 59: ANOVA Summary for 1994 Average Quota Holding ($): Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	6.29E+09	1	6.29E+09	2.602279	0.115443	4.113161
Within Groups	8.7E+10	36	2.42E+09			
Total	9.33E+10	37				

TABLE 60: ANOVA Summary for 1994 Average Quota Holding ($): Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	5.05E+11	1	5.05E+11	**42.75391***	6.23E-07	4.2252
Within Groups	3.07E+11	26	1.18E+10			
Total	8.12E+11	27				

TABLE 61: ANOVA Summary for 1994 Average Quota Holding ($): Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	4.9E+11	1	4.9E+11	**45.06816***	1.04E-07	4.130015
Within Groups	3.7E+11	34	1.09E+10			
Total	8.6E+11	35				

APPENDIX C

ANOVA Summary for Farm Data Characteristics

Milk Yield Distribution of Data

TABLE 1: ANOVA Summary for 1996 Average Milk Yield Per Cow (hl/cow): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	4736.831	2	2368.416	**98.57485***	2.2E-19	3.155932
Within Groups	1393.541	58	24.12657			
Total	6130.372	60				

TABLE 2: ANOVA Summary for 1996 Average Milk Yield Per Cow (hl/cow): Groups M1 and M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1377.568	1	1377.568	**53.18669***	8.52E-09	4.091277
Within Groups	1010.124	39	25.90062			
Total	2387.692	40				

TABLE 3: ANOVA Summary for 1996 Average Milk Yield Per Cow (hl/cow): Groups M1 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	4735.402	1	4735.402	**140.2504***	3.76E-14	4.105459
Within Groups	1249.265	37	33.76391			
Total	5984.666	38				

TABLE 4: ANOVA Summary for 1996 Average Milk Yield Per Cow (hl/cow): Groups M2 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1137.756	1	1137.756	**86.24367***	1.56E-11	4.08474
Within Groups	527.6936	40	13.19234			
Total	1665.449	41				

TABLE 5: ANOVA Summary for 1996 Average Years Farming: Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	41.48251	2	20.74126	0.189018	0.82828	3.155932
Within Groups	6364.452	58	109.7319			
Total	6405.934	60				

TABLE 6: ANOVA Summary for 1996 Average Percent Dairy Income: Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	673.8382	2	336.9191	0.991516	0.377214	3.155932
Within Groups	1970.52	58	339.8021			
Total	20382.36	60				

TABLE 7: ANOVA Summary for 1996 Average Annual Milk Production (hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	18954729	2	9477364	0.991818	0.377104	3.155932
Within Groups	5.54E+08	58	9555550			
Total	5.73E+08	60				

TABLE 8: ANOVA Summary for 1996 Average Number of Dairy Cows: Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	79.92358	2	39.96179	0.028451	0.971963	3.155932
Within Groups	81464.51	58	1404.56			
Total	81544.43	60				

TABLE 9: ANOVA Summary for 1996 Average Quota Holding (hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	9959545	2	4979772	0.0803769	0.452561	3.155932
Within Groups	3.59E+08	58	6195524			
Total	3.69E+08	60				

TABLE 10: ANOVA Summary for 1996 Average Percent Over Quota Milk Production: Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	3233.263	2	1616.631	**7.37053***	0.001405	3.155932
Within Groups	12721.56	58	219.3372			
Total	15954.82	60				

TABLE 11: ANOVA Summary for 1996 Average Percent Over Quota Milk Production: Groups M1 and M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	10.42002	1	10.42002	0.054404	0.816789	4.091277
Within Groups	7469.649	39	191.5294			
Total	7480.069	40				

TABLE 12: ANOVA Summary for 1996 Average Percent Over Quota Milk Production: Groups M1 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2502.557	1	2502.557	**11.84643***	0.001449	4.105459
Within Groups	7816.246	37	211.2499			
Total	10318.8	38				

TABLE 13: ANOVA Summary for 1996 Average Percent Over Quota Milk Production: Groups M2 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2361.955	1	2361.955	**9.301579***	0.004051	4.08474
Within Groups	10157.22	40	253.9305			
Total	12519.17	41				

TABLE 14: ANOVA Summary for 1996 Average Quota Holding ($): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	3.04E+10	2	1.52E+10	0.731242	0.485695	3.155932
Within Groups	1.2E+12	58	2.08E+10			
Total	1.24E+12	60				

TABLE 15: ANOVA Summary for 1995 Average Milk Yield Per Cow (hl/cow): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	6534.662	2	3267.331	**165.1254***	5.41E-26	3.140443
Within Groups	1266.366	64	19.78696			
Total	7801.028	66				

TABLE 16: ANOVA Summary for 1995 Average Milk Yield Per Cow (hl/cow): Groups M1 and M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2991.377	1	2991.377	**139.6037***	4.38E-16	4.03432
Within Groups	1071.381	50	21.42763			
Total	4062.758	51				

TABLE 17: ANOVA Summary for 1995 Average Milk Yield Per Cow (hl/cow): Groups M1 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	6067.553	1	6067.553	**206.175***	1.05E-16	4.105459
Within Groups	1088.879	37	29.42915			
Total	7156.432	38				

TABLE 18: ANOVA Summary for 1995 Average Milk Yield Per Cow (hl/cow): Groups M2 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1061.307	1	1061.307	**116.8239***	1.43E-13	4.078544
Within Groups	372.4716	41	9.084673			
Total	1433.779	42				

TABLE 19: ANOVA Summary for 1995 Average Years Farming: Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	115.9956	2	57.99778	0.528415	0.592088	3.140443
Within Groups	7024.512	64	109.758			
Total	7140.507	66				

TABLE 20: ANOVA Summary for 1995 Average Annual Milk Production (hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	19566855	2	9783428	0.986192	0.37859	3.140443
Within Groups	6.35E+08	64	9920410			
Total	6.54E+08	66				

TABLE 21: ANOVA Summary for 1995 Average Number of Dairy Cows: Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1391.526	2	695.7628	0.465306	0.630051	3.1400443
Within Groups	95698	64	1495.281			
Total	97089.52	66				

TABLE 22: ANOVA Summary for 1995 Average Quota Holding (hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	13086028	2	6543014	1.053502	0.354683	3.140443
Within Groups	3.97E+08	64	6210728			
Total	4.11E+08	66				

TABLE 23: ANOVA Summary for 1995 Average Percent Over Quota Milk Production: Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1037.323	2	518.6613	1.738157	0.184042	3.140443
Within Groups	19097.43	64	298.3973			
Total	20134.75	66				

TABLE 24: ANOVA Summary for 1995 Average Quota Holding ($): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	3.4E+10	2	1.7E+10	0.930434	0.399651	3.140443
Within Groups	1.17E+12	64	1.83E+10			
Total	1.2E+12	66				

TABLE 25: ANOVA Summary for 1994 Average Milk Yield Per Cow (hl/cow): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	8248.364	2	4124.182	**158.6232***	6.4E-27	3.125763
Within Groups	1845.99	71	25.99986			
Total	10094.35	73				

TABLE 26: ANOVA Summary for 1994 Average Milk Yield Per Cow (hl/cow): Groups M1 and M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2424.733	1	2424.733	**102.8906***	7.92E-14	4.030397
Within Groups	1201.873	51	23.56614			
Total	3626.606	52				

TABLE 27: ANOVA Summary for 1994 Average Milk Yield Per Cow (hl/cow): Groups M1 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	7984.26	1	7984.26	**240.6253***	3.75E-21	4.026631
Within Groups	1725.428	52	33.1813			
Total	9709.687	53				

TABLE 28: ANOVA Summary for 1994 Average Milk Yield Per Cow (hl/cow): Groups M2 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1237.026	1	1237.026	**63.09043***	1.13E-09	4.091277
Within Groups	764.6801	39	19.60718			
Total	2001.706	40				

TABLE 29: ANOVA Summary for 1994 Average Years Farming: Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	954.519	2	477.2596	**4.959353***	0.009637	3.125763
Within Groups	6832.63	71	96.23422			
Total	7787.149	73				

TABLE 30: ANOVA Summary for 1994 Average Years Farming: Groups M1 and M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	908.3982	1	908.3982	**11.74154***	0.001216	4.030397
Within Groups	3945.677	51	77.36622			
Total	4854.075	52				

TABLE 31: ANOVA Summary for 1994 Average Years Farming: Groups M1 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	27.80183	1	27.80183	0.23088	0.632888	4.026631
Within Groups	6261.68	52	120.4169			
Total	6289.481	53				

TABLE 32: ANOVA Summary for 1994 Average Years Farming: Groups M2 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	511.9025	1	511.9025	**5.773499***	0.021126	4.091277
Within Groups	3457.902	39	88.66416			
Total	3969.805	40				

TABLE 33: ANOVA Summary for 1994 Average Annual Milk Production (hl):Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	33482931	2	16741466	1.896841	0.157568	3.125763
Within Groups	6.17E+08	71	8825972			
Total	6.6E+08	73				

TABLE 34: ANOVA Summary for 1994 Average Number of Dairy Cows: Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	144.6286	2	72.31432	0.055165	0.94637	3.125763
Within Groups	93072.35	71	1310.878			
Total	93216.98	73				

TABLE 35: ANOVA Summary for 1994 Average Quota Holding (hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	6931904	2	3465952	0.609819	0.546271	3.125763
Within Groups	4.04E+08	71	5683579			
Total	4.1E+08	73				

TABLE 36: ANOVA Summary for 1994 Average Percent Over Quota Milk Production: Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2219.279	2	1109.639	**3.473471***	0.036375	3.125763
Within Groups	22681.75	71	319.4612			
Total	24901.02	73				

TABLE 37: ANOVA Summary for 1994 Average Percent Over Quota Milk Production: Groups M1 and M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	16.27513	1	16.27513	0.053643	0.817769	4.030397
Within Groups	15473.39	51	303.3998			
Total	15489.67	52				

TABLE 38: ANOVA Summary for 1994 Average Percent Over Quota Milk Production: Groups M1 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2016.107	1	2016.107	**6.161168***	0.016326	4.026631
Within Groups	17015.86	52	327.228			
Total	19031.97	53				

TABLE 39: ANOVA Summary for 1994 Average Percent Over Quota Milk Production: Groups M2 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1329.128	1	1329.128	4.026334	0.051764	4.091277
Within Groups	1287.24	39	330.1088			
Total	14203.37	40				

TABLE 40: ANOVA Summary for 1994 Average Quota Holding ($): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.49E+10	2	7.45E+09	0.455093	0.636226	3.125763
Within Groups	1.16E+12	71	1.64E+10			
Total	1.18E+12	73				

APPENDIX D

ANOVA Summary for Average Dairy Economic Costs of Production

Herd Size Distribution of Data

TABLE 1: ANOVA Summary for 1996 Average Feed Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	20.38349	2	10.19175	0.842979	0.437259	3.20928
Within Groups	531.9668	44	12.09016			
Total	552.3503	46				

TABLE 2: ANOVA Summary for 1996 Average Processing Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.292589	2	0.146295	2.070856	0.138193	3.20928
Within Groups	3.108358	44	0.070644			
Total	3.400947	46				

TABLE 3: ANOVA Summary for 1996 Average Bedding and Supplies Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2.234045	2	1.117022	3.149182	0.052696	3.20928
Within Groups	15.6069	44	0.354702			
Total	17.84095	46				

TABLE 4: ANOVA Summary for 1996 Average Breeding Cost per Hectolitre: Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.189269	2	0.094635	0.555335	0.57785	3.20928
Within Groups	7.498048	44	0.17041			
Total	7.687318	46				

TABLE 5: ANOVA Summary for 1996 Average Veterinary and Medicine Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.652786	2	0.326393	0.555335	0.57785	3.20928
Within Groups	25.86062	44	0.587741			
Total	26.5134	46				

TABLE 6: ANOVA Summary for 1996 Average Milk Hauling Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.029936	2	0.014968	0.685022	0.509374	3.20928
Within Groups	0.961421	44	0.02185			
Total	0.991357	46				

TABLE 7: ANOVA Summary for 1996 Average Producer Fee ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.003948	2	0.001974	2.747939	0.075065	3.20928
Within Groups	0.031606	44	0.000718			
Total	0.035554	46				

TABLE 8: ANOVA Summary for 1996 Average Utilities Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.185287	2	0.092644	0.564415	0.572755	3.20928
Within Groups	7.222205	44	0.164141			
Total	7.407492	46				

TABLE 9: ANOVA Summary for 1996 Average Fuel, Oil, and Lube Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.82067	2	0.910335	**6.139523***	0.00445	3.20928
Within Groups	6.524081	44	0.148275			
Total	8.344751	46				

TABLE 10: ANOVA Summary for 1996 Average Fuel, Oil and Lube Cost ($/hl): Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.038471	1	1.038471	**6.236207***	0.018036	4.159617
Within Groups	5.162208	31	0.166523			
Total	6.200679	32				

TABLE 11: ANOVA Summary for 1996 Average Fuel, Oil, and Lube Cost ($/hl): Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.749746	1	1.749746	**9.374169***	0.005526	4.279343
Within Groups	4.29309	23	0.186656			
Total	6.042836	24				

TABLE 12: ANOVA Summary for 1996 Average Fuel, Oil, and Lube Cost ($/hl): Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.209953	1	0.209953	1.98683	0.167755	4.130015
Within Groups	3.592864	34	0.105672			
Total	3.802818	35				

TABLE 13: ANOVA Summary for 1996 Average Rent Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	5.651866	2	2.825933	2.131806	0.130714	3.20928
Within Groups	58.32662	44	1.325605			
Total	63.97848	46				

TABLE 14: ANOVA Summary for 1996 Average Miscellaneous Costs ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	14.02804	2	7.01402	**3.491758***	0.039129	3.20928
Within Groups	88.38438	44	2.008726			
Total	102.4124	46				

TABLE 15: ANOVA Summary for 1996 Average Miscellaneous Costs ($/hl): Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	5.868379	1	5.868379	2.27113	0.141928	4.159617
Within Groups	80.10099	31	2.583903			
Total	85.96937	32				

TABLE 16: ANOVA Summary for 1996 Average Miscellaneous Costs ($/hl): Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.610155	1	0.610155	0.705425	0.409613	4.279343
Within Groups	19.89376	23	0.864946			
Total	20.50392	24				

TABLE 17: ANOVA Summary for 1996 Average Miscellaneous Costs ($/hl): Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	12.51132	1	12.51132	**5.54074***	0.024498	4.130015
Within Groups	76.77401	34	2.258059			
Total	89.28533	35				

TABLE 18: ANOVA Summary for 1996 Average Hired Labour Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	122.6692	2	61.33461	**21.69833***	2.77E-07	3.20928
Within Groups	124.3747	44	2.826697			
Total	247.1439	46				

TABLE 19: ANOVA Summary for 1996 Average Hired Labour Cost ($/hl): Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	16.71647	1	16.71647	**8.401706***	0.006827	4.159617
Within Groups	61.67922	31	1.989652			
Total	78.39569	32				

TABLE 20: ANOVA Summary for 1996 Average Hired Labour Cost ($/hl): Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	113.3501	1	113.3501	**39.18769***	2.18E-06	4.279343
Within Groups	66.52735	23				
Total	179.8775	24				

TABLE 21: ANOVA Summary for 1996 Average Hired Labour Cost ($/hl): Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	66.11269	1	66.11269	18.64758*	0.000129	4.130015
Within Groups	120.5428	34	3.545377			
Total	186.6555	35				

TABLE 22: ANOVA Summary for 1996 Average Unpaid Family Labour Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	21.25968	2	10.62984	3.120172	0.054051	3.20928
Within Groups	149.8997	44	3.406812			
Total	171.1594	46				

TABLE 23: ANOVA Summary for 1996 Average Operator Labour Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	275.8635	2	137.9317	33.59468*	1.39E-09	3.20928
Within Groups	180.6535	44	4.105761			
Total	456.517	46				

TABLE 24: ANOVA Summary for 1996 Average Operator Labour Cost ($/hl): Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	27.20574	1	27.20574	4.91302*	0.034125	4.159617
Within Groups	171.6618	31	5.537478			
Total	198.8676	32				

TABLE 25: ANOVA Summary for 1996 Average Operator Labour Cost ($/hl): Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	245.5484	1	245.5484	47.20105*	5.26E-07	4.279343
Within Groups	119.6502	23	5.202181			
Total	365.1986	24				

TABLE 26: ANOVA Summary for 1996 Average Operator Labour Cost ($/hl): Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	164.6968	1	164.6968	80.00127*	1.87E-10	4.130015
Within Groups	69.99501	34	2.058677			
Total	234.6918	35				

TABLE 27: ANOVA Summary for 1996 Average Insurance and Tax Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.133225	2	0.066612	0.493995	0.613527	3.20928
Within Groups	5.933144	44	0.134844			
Total	6.066369	46				

TABLE 28: ANOVA Summary for 1996 Average Repairs Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.436897	2	0.718449	1.00949	0.372688	3.20928
Within Groups	31.31458	44	0.711695			
Total	32.75147	46				

TABLE 29: ANOVA Summary for 1996 Average User Cost of Buildings ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	3.111964	2	1.555982	0.219962	0.803427	3.20928
Within Groups	311.2505	44	7.073875			
Total	314.3624	46				

TABLE 30: ANOVA Summary for 1996 Average User Cost of Machinery & Equipment ($/hl): Groups H1, H2, H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.155215	2	0.077608	0.038659	0.962111	3.20928
Within Groups	8.32976	44	2.007494			
Total	88.48497	46				

TABLE 31: ANOVA Summary for 1996 Average User Cost of Land ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.098819	2	0.04941	1.468329	0.241374	3.20928
Within Groups	1.48061	44	0.03365			
Total	1.579429	46				

TABLE 32: ANOVA Summary for 1996 Average Total Variable Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	49.40311	2	24.70155	1.605873	0.212255	3.20928
Within Groups	676.8085	44	15.38201			
Total	726.2116	46				

TABLE 33: ANOVA Summary for 1996 Average Total Labour Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	103.8868	2	51.94341	**9.758933***	0.000311	3.20928
Within Groups	234.1967	44	5.322653			
Total	338.0836	46				

TABLE 34: ANOVA Summary for 1996 Average Total Labour Cost ($/hl): Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	5.899612	1	5.899612	1.101041	0.30215	4.159617
Within Groups	166.1046	31	5.358212			
Total	172.0042	32				

TABLE 35: ANOVA Summary for 1996 Average Total Labour Cost ($/hl): Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	86.86696	1	86.86696	**15.70597***	0.000617	4.279343
Within Groups	127.209	23	5.530825			
Total	214.0759	24				

TABLE 36: ANOVA Summary for 1996 Average Total Labour Cost ($/hl): Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	69.8977	1	69.89777	13.57394*	0.000792	4.130015
Within Groups	175.0799	34	5.149408			
Total	244.9777	35				

TABLE 37: ANOVA Summary for 1996 Average Total Costs of Production ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	228.01	2	114.005	2.745322	0.07524	3.20928
Within Groups	1827.188	44	41.527			
Total	2055.198	46				

TABLE 38: ANOVA Summary for 1995 Average Feed Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.607232	2	0.803616	0.144767	0.865625	3.20432
Within Groups	249.7998	45	5.551107			
Total	251.407	47				

TABLE 39: ANOVA Summary for 1995 Average Processing Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.03703	2	0.018515	0.26571	0.767856	3.20432
Within Groups	3.135672	45	0.069682			
Total	3.172702	47				

TABLE 40: ANOVA Summary for 1995 Average Bedding and Supplies Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.197014	2	0.098507	0.291384	0.748628	3.20432
Within Groups	15.21298	45	0.338066			
Total	15.41	47				

TABLE 41: ANOVA Summary for 1995 Average Breeding Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.035987	2	0.517994	1.942069	0.15524	3.20432
Within Groups	12.00252	45	0.266723			
Total	13.0385	47				

TABLE 42: ANOVA Summary for 1995 Average Veterinary and Medicine Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.571801	2	0.285901	1.080898	0.347936	3.20432
Within Groups	11.90263	45	0.264503			
Total	12.47444	47				

TABLE 43: ANOVA Summary for 1995 Average Milk Hauling Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.0526	2	0.026308	2.170275	0.125948	3.20432
Within Groups	0.54548	45	0.012122			
Total	0.598095	47				

TABLE 44: ANOVA Summary for 1995 Average Producer Fee ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.005355	2	0.002678	1.162082	0.322044	3.20432
Within Groups	0.103686	45	0.002304			
Total	0.109041	47				

TABLE 45: ANOVA Summary for 1995 Average Utilities Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.566632	2	0.283316	**3.27767***	0.046895	3.20432
Within Groups	3.889718	45	0.086438			
Total	4.45635	47				

TABLE 46: ANOVA Summary for 1995 Average Utilities Cost ($/hl): Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.001572	1	0.001572	0.016772	0.897768	4.149086
Within Groups	2.999245	32	0.093726			
Total	3.000817	33				

TABLE 47: ANOVA Summary for 1995 Average Utilities Cost ($/hl): Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.372168	1	0.372168	**4.680125***	0.039887	4.2252
Within Groups	2.067547	26	0.079521			
Total	2.439715	27				

TABLE 48: ANOVA Summary for 1995 Average Utilities Cost ($/hl): Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.491887	1	0.491887	**5.802598***	0.021934	4.149086
Within Groups	2.712645	32	0.08477			
Total	3.204532	33				

TABLE 49: ANOVA Summary for 1995 Average Fuel, Oil, and Lube Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.370667	2	0.185333	1.565159	0.220222	3.20432
Within Groups	5.328536	45	0.118412			
Total	5.699203	47				

TABLE 50: ANOVA Summary for 1995 Average Rent Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.551499	2	0.275749	0.771702	0.468245	3.20432
Within Groups	16.07969	45	0.357326			
Total	16.63119	47				

TABLE 51: ANOVA Summary for 1995 Average Miscellaneous Costs ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.738703	2	0.869351	0.442024	0.645557	3.20432
Within Groups	86.53699	45	1.96675			
Total	88.27569	47				

TABLE 52: ANOVA Summary for 1995 Average Hired Labour Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	13.88402	2	6.94201	2.227109	0.119593	3.20432
Within Groups	140.2672	45	3.11705			
Total	154.1513	47				

TABLE 53: ANOVA Summary for 1995 Average Unpaid Family Labour Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	114.487	2	57.24352	**24.75267***	5.62E-08	3.20432
Within Groups	104.0679	45	2.31262			
Total	218.5549	47				

TABLE 54: ANOVA Summary for 1995 Average Unpaid Family Labour Cost ($/hl): Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	11.95238	1	11.95238	3.943935	0.55664	4.149086
Within Groups	96.97834	32	3.030573			
Total	108.9307	33				

TABLE 55: ANOVA Summary for 1995 Average Unpaid Family Labour Cost ($/hl): Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	107.7949	1	107.7949	**32.74528***	5.05E-06	4.2252
Within Groups	85.58997	26	3.291922			
Total	193.3849	27				

TABLE 56: ANOVA Summary for 1995 Average Unpaid Family Labour Cost ($/hl): Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	60.9041	1	60.9041	76.227*	5.62E-10	4.149086
Within Groups	25.56747	32	0.798983			
Total	86.47157	33				

TABLE 57: ANOVA Summary for 1995 Average Operator Labour Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	292.1191	2	146.0595	24.61363*	6E-08	3.20432
Within Groups	267.0341	45	5.93409			
Total	559.1531	47				

TABLE 58: ANOVA Summary for 1995 Average Operator Labour Cost ($/hl): Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	30.47983	1	30.47983	3.928686	0.056112	4.149086
Within Groups	248.2648	32	7.758276			
Total	278.7447	33				

TABLE 59: ANOVA Summary for 1995 Average Operator Labour Cost ($/hl): Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	275.0306	1	275.0306	32.2464*	5.66E-06	4.2252
Within Groups	221.7548	26	8.529031			
Total	496.7853	27				

TABLE 60: ANOVA Summary for 1995 Average Operator Labour Cost ($/hl): Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	155.4278	1	155.4278	77.65505*	4.55E-10	4.149086
Within Groups	64.0485	32	2.001516			
Total	219.4763	33				

TABLE 61: ANOVA Summary for 1995 Average Insurance and Tax Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.876937	2	0.438469	2.654832	0.081306	3.20432
Within Groups	7.432144	45	0.165159			
Total	8.309081	47				

TABLE 62: ANOVA Summary for 1995 Average Repairs Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.281566	2	0.140783	0.185208	0.831561	3.20432
Within Groups	34.206	45	0.760133			
Total	34.48756	47				

TABLE 63: ANOVA Summary for 1995 Average User Cost of Buildings ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.033496	2	0.516748	0.096633	0.908077	3.20432
Within Groups	240.6379	45	5.347509			
Total	241.6714	47				

TABLE 64: ANOVA Summary for 1995 Average User Cost of Machinery & Equipment ($/hl): Groups H1, H2, H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	6.097786	2	3.048893	1.505253	0.232925	3.20432
Within Groups	91.14759	45	2.025502			
Total	97.24538	47				

TABLE 65: ANOVA Summary for 1995 Average User Cost of Land ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.710102	2	0.855051	**6.04763***	0.004718	3.20432
Within Groups	6.362377	45				
Total	8.072479	47				

TABLE 66: ANOVA Summary for 1995 Average User Cost of Land ($/hl): Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.121037	1	0.121037	0.675413	0.417252	4.149086
Within Groups	5.734535	32	0.179204			
Total	5.855572	33				

TABLE 67: ANOVA Summary for 1995 Average User Cost of Land ($/hl): Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.556949	1	1.556949	**18.84094***	0.000191	4.2252
Within Groups	2.148548	26	0.082636			
Total	3.705496	27				

TABLE 68: ANOVA Summary for 1995 Average User Cost of Land ($/hl): Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.011032	1	1.011032	**6.682205***	0.014502	4.149086
Within Groups	4.841671	32	0.151302			
Total	5.852703	33				

TABLE 69: ANOVA Summary for 1995 Average User Cost of Dairy Herd ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.015796	2	0.007898	0.259167	0.772838	3.20432
Within Groups	1.371316	45	0.030474			
Total	1.387112	47				

TABLE 70: ANOVA Summary for 1995 Average Total Variable Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	4.651788	2	2.325894	0.207594	0.81331	3.20432
Within Groups	504.1819	45	11.20404			
Total	508.8337	47				

TABLE 71: ANOVA Summary for 1995 Average Total Labour Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	847.211	2	423.6055	**23.96955***	8.18E-08	3.20432
Within Groups	795.2693	45	17.67265			
Total	1642.48	47				

TABLE 72: ANOVA Summary for 1995 Average Total Labour Cost ($/hl): Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	35.54956	1	35.54956	1.697811	0.201873	4.149086
Within Groups	670.0311	32	20.93847			
Total	705.5807	33				

TABLE 73: ANOVA Summary for 1995 Average Total Labour Cost ($/hl): Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	738.1898	1	738.1898	**31.1693***	7.27E-06	4.2252
Within Groups	615.7641	26	23.68324			
Total	1353.954	27				

TABLE 74: ANOVA Summary for 1995 Average Total Labour Cost ($/hl): Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	552.5921	1	552.5921	**58.02569***	1.11E-08	4.149086
Within Groups	304.7434	32	9.523232			
Total	857.3355	33				

TABLE 75: ANOVA Summary for 1995 Average Total Costs of Production ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1018.337	2	509.1685	**9.473198***	0.000368	3.20432
Within Groups	2418.674	45	53.74832			
Total	3437.011	47				

TABLE 76: ANOVA Summary for 1994 Average Feed Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	10.88573	2	5.442864	0.454454	0.637497	3.190721
Within Groups	574.8816	48	11.9767			
Total	585.7674	50				

TABLE 77: ANOVA Summary for 1994 Average Processing Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.161289	2	0.080645	1.759654	0.183024	3.190721
Within Groups	2.199831	48	0.04583			
Total	2.361121	50				

TABLE 78: ANOVA Summary for 1994 Average Bedding and Supplies Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2.088796	2	1.044398	1.288108	0.285153	3.190721
Within Groups	38.9184	48	0.8108			
Total	41.0072	50				

TABLE 79: ANOVA Summary for 1994 Average Breeding Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.195774	2	0.597887	1.347385	0.269572	3.190721
Within Groups	21.29948	48	0.443739			
Total	22.49525	50				

TABLE 80: ANOVA Summary for 1994 Average Veterinary and Medicine Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.970927	2	0.485463	1.039636	0.361408	3.190721
Within Groups	22.41385	48	0.466955			
Total	23.38478	50				

TABLE 81: ANOVA Summary for 1994 Average Milk Hauling Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.014498	2	0.007249	0.244928	0.783733	3.190721
Within Groups	1.420662	48	0.029597			
Total	1.435161	50				

TABLE 82: ANOVA Summary for 1994 Average Producer Fee ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.205383	2	0.102692	**9.814667***	0.000267	3.190721
Within Groups	0.502228	48	0.010463			
Total	0.707611	50				

TABLE 83: ANOVA Summary for 1994 Average Producer Fee ($/hl): Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.87489	1	0.087489	**6.421211***	0.01577	4.113161
Within Groups	0.490501	36	0.013625			
Total	0.577991	37				

TABLE 84: ANOVA Summary for 1994 Average Producer Fee ($/hl): Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.200651	1	0.200651	**18.66259***	0.000202	4.2252
Within Groups	0.27954	26	0.010752			
Total	0.480191	27				

TABLE 85: ANOVA Summary for 1994 Average Producer Fee ($/hl): Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.200651	1	0.200651	**18.66259***	0.000202	4.2252
Within Groups	0.27954	26	0.010752			
Total	0.480191	27				

TABLE 86: ANOVA Summary for 1994 Average Utilities Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.686919	2	0.343459	2.434309	0.09841	3.190721
Within Groups	6.772372	48	0.141091			
Total	7.459291	50				

TABLE 87: ANOVA Summary for 1994 Average Fuel, Oil, and Lube Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.182584	2	0.091292	0.974887	0.384579	3.190721
Within Groups	4.494895	48	0.936644			
Total	4.677479	50				

TABLE 88: ANOVA Summary for 1994 Average Rent Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.591071	2	0.295536	1.000801	0.375125	3.190721
Within Groups	14.17435	48	0.295299			
Total	14.76542	50				

TABLE 89: ANOVA Summary for 1994 Average Miscellaneous Costs ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2.076508	2	1.038254	0.780571	0.463872	3.190721
Within Groups	63.84579	48	1.330121			
Total	65.9223	50				

TABLE 90: ANOVA Summary for 1994 Average Hired Labour Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	6.265267	2	3.132634	0.806773	0.452255	3.190721
Within Groups	186.3801	48	3.882918			
Total	192.6453	50				

TABLE 91: ANOVA Summary for 1994 Average Unpaid Family Labour Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	128.0499	2	64.02494	**34.77081***	4.63E-10	3.190721
Within Groups	88.38439	48	1.841342			
Total	216.4343	50				

TABLE 92: ANOVA Summary for 1994 Average Unpaid Family Labour Cost ($/hl): Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	7.981332	1	7.981332	3.516552	0.068888	4.113161
Within Groups	81.7073	36	2.269647			
Total	89.68863	37				

TABLE 93: ANOVA Summary for 1994 Average Unpaid Family Labour Cost ($/hl): Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	116.4	1	116.4	**99.76944***	2.17E-10	4.2252
Within Groups	30.33393	26	1.16669			
Total	146.7339	27				

TABLE 94: ANOVA Summary for 1994 Average Unpaid Family Labour Cost ($/hl): Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	82.44596	1	82.44596	**43.30709***	1.53E-07	4.130015
Within Groups	64.72757	34	1.903752			
Total	147.1735	35				

TABLE 95: ANOVA Summary for 1994 Average Operator Labour Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	220.2595	2	110.1298	**35.73951***	3.12E-10	3.190721
Within Groups	47.91	48	3.081457			
Total	368.1695	50				

TABLE 96: ANOVA Summary for 1994 Average Operator Labour Cost ($/hl): Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	14.76497	1	14.76497	3.858957	0.057237	4.113161
Within Groups	137.7416	36	3.826155			
Total	152.5066	37				

TABLE 97: ANOVA Summary for 1994 Average Operator Labour Cost ($/hl): Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	201.4156	1	201.4156	**103.1419***	1.53E-10	4.2252
Within Groups	50.77281	26	1.9528			
Total	252.1884	27				

TABLE 98: ANOVA Summary for 1994 Average Operator Labour Cost ($/hl): Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	139.7925	1	139.7925	**44.29359***	1.23E-07	4.130015
Within Groups	107.3055	34	3.156045			
Total	247.098	35				

TABLE 99: ANOVA Summary for 1994 Average Insurance and Tax Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.060947	2	0.030473	0.284273	0.753819	3.190721
Within Groups	5.145477	48	0.107197			
Total	5.206423	50				

TABLE 100: ANOVA Summary for 1994 Average Repairs Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.016127	2	0.008064	0.005073	0.99494	3.190721
Within Groups	76.29556	48	1.589491			
Total	76.31169	50				

TABLE 101: ANOVA Summary for 1994 Average User Cost of Buildings ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	9.042431	2	4.521215	0.79133	0.459065	3.190721
Within Groups	274.2449	48	5.713436			
Total	283.2874	50				

TABLE 102: ANOVA Summary for 1994 Average User Cost of Machinery & Equipment ($/hl): Groups H1, H2, H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	21.93171	2	10.96585	**4.904101***	0.011536	3.190721
Within Groups	107.3308	48	2.236058			
Total	129.2625	50				

TABLE 103: ANOVA Summary for 1994 Average User Cost of Machinery & Equipment ($/hl): Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	15.24509	1	15.24509	**5.985267***	0.019441	4.113161
Within Groups	91.69569	36	2.547102			
Total	106.9408	37				

TABLE 104: ANOVA Summary for 1994 Average User Cost of Machinery and Equipment ($/hl): Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	18.16827	1	18.16827	**5.348259***	0.028919	4.2252
Within Groups	88.32315	26	3.397044			
Total	106.4914	27				

TABLE 105: ANOVA Summary for 1994 Average User Cost of Machinery and Equipment ($/hl): Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.847002	1	0.847002	0.831288	0.36832	4.130015
Within Groups	34.64275	34	1.018904			
Total	35.48975	35				

TABLE 106: ANOVA Summary for 1994 Average User Cost of Land ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2.650611	2	1.325305	2.754564	0.073709	3.190721
Within Groups	23.09427	48	0.481131			
Total	25.74488	50				

TABLE 107: ANOVA Summary for 1994 Average User Cost of Dairy Herd ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.113354	2	0.056677	1.115232	0.336184	3.190721
Within Groups	2.4394	48	0.050821			
Total	2.5527	50				

TABLE 108: ANOVA Summary for 1994 Average Total Variable Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	31.82994	2	15.91497	0.83919	0.4383	3.190721
Within Groups	910.3044	48	18.96467			
Total	942.1343	50				

TABLE 109: ANOVA Summary for 1994 Average Total Labour Cost ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	819.5145	2	409.7573	**32.12223***	1.4E-09	3.190721
Within Groups	612.2971	48	12.75619			
Total	1431.812	50				

TABLE 110: ANOVA Summary for 1994 Average Total Labour Cost ($/hl): Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	59.35502	1	59.35502	**4.117465***	0.049887	4.113161
Within Groups	518.9553	36	14.41543			
Total	578.3104	37				

TABLE 111: ANOVA Summary for 1994 Average Total Labour Cost ($/hl): Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	754.18	1	754.18	**84.0643***	1.25E-09	4.2252
Within Groups	233.2581	26	8.971466			
Total	987.4381	27				

TABLE 112: ANOVA Summary for 1994 Average Total Labour Cost ($/hl): Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	511.7419	1	511.7419	**36.83306***	7.01E-07	4.130015
Within Groups	472.3807	34	13.89355			
Total	984.1226	35				

TABLE 113: ANOVA Summary for 1994 Average Total Costs of Production ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1378.181	2	689.0903	**13.17208***	2.75E-05	3.190721
Within Groups	2511.095	48	52.31448			
Total	3889.276	50				

TABLE 114: ANOVA Summary for Average Total Cost of Production of Group H1 ($/hl): 1994 - 1995

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	50.68842	1	50.68842	0.613864	0.440156	4.210008
Within Groups	2229.464	27	82.57273			
Total	2280.152	28				

TABLE 115: ANOVA Summary for Average Total Cost of Production of Group H1 ($/hl): 1995 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.029302	1	1.029302	0.015098	0.903276	4.279343
Within Groups	1568.069	23	68.17691			
Total	1569.098	24				

TABLE 116: ANOVA Summary for Average Total Cost of Production of Group H1 ($/hl): 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	31.75573	1	31.75573	0.443106	0.511975	4.259675
Within Groups	1719.99	24	71.66626			
Total	1751.746	25				

TABLE 117: ANOVA Summary for Average Total Cost of Production of Group H2 ($/hl): 1994 - 1995

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	5.780428	1	5.780428	0.139502	0.710701	4.078544
Within Groups	1698.882	41	41.43615			
Total	1704.662	42				

TABLE 118: ANOVA Summary for Average Total Cost of Production of Group H2 ($/hl): 1995 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	3.530304	1	3.530304	0.082665	0.775202	4.08474
Within Groups	1708.25	40	42.70624			
Total	1711.78	41				

TABLE 119: ANOVA Summary for Average Total Cost of Production of Group H2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.26868	1	0.26868	0.007024	0.933597	4.067047
Within Groups	1644.838	43	38.25205			
Total	1645.107	44				

TABLE 120: ANOVA Summary for Average Total Cost of Production of Group H3 ($/hl): 1994 - 1995

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2.646706	1	2.646706	0.066074	0.799246	4.241699
Within Groups	1001.424	25	40.05695			
Total	1004.07	26				

TABLE 121: ANOVA Summary for Average Total Cost of Production of Group H3 ($/hl): 1995 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	188.0679	1	188.0679	**5.043366***	0.033441	4.2252
Within Groups	969.544	26	37.29015			
Total	1157.612	27				

TABLE 122: ANOVA Summary for Average Total Cost of Production of Group H3 ($/hl): 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	227.5361	1	227.5361	**5.843518***	0.023258	4.241699
Within Groups	973.4551	25	389382			
Total	1200.991	26				

TABLE 123: ANOVA Summary for Change in Average Feed Cost of Group H3 ($/hl): 1995 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	75.94614	1	75.94614	**8.271559***	0.007935	4.2252
Within Groups	238.7216	26	9.181599			
Total	314.6677	27				

TABLE 124: ANOVA Summary for Change in Average Processing Cost of Group H3 ($/hl): 1995 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.030626	1	0.030626	0.5079	0.482397	4.2252
Within Groups	1.567776	26	0.060299			
Total	1.598402	27				

TABLE 125: ANOVA Summary for Change in Average Bedding and Supplies Cost of Group H3 ($/hl): 1995 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	9.64E-05	1	9.64E-05	0.00059	0.980808	4.2252
Within Groups	4.249202	26	0.163431			
Total	4.249298	27				

TABLE 126: ANOVA Summary for Change in Average Breeding Cost of Group H3 ($/hl): 1995 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.276512	1	0.276512	1.756098	0.19664	4.2252
Within Groups	4.093907	26	0.157458			
Total	4.370418	27				

TABLE 127: ANOVA Summary for Change in Average Vet and Medicine Cost of Group H3 ($/hl): 1995 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.199226	1	0.199226	0.422121	0.52158	4.2252
Within Groups	12.27106	26	0.471964			
Total	12.47029	27				

TABLE 128: ANOVA Summary for Change in Average Milk Hauling Cost of Group H3 ($/hl): 1995 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2.57E-05	1	2.57E-05	0.000849	0.976983	4.2252
Within Groups	0.788022	26	0.030309			
Total	0.788048	27				

TABLE 129: ANOVA Summary for Change in Average Producer Fee of Group H3 ($/hl): 1995 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.006017	1	0.006017	**8.329876***	0.007745	4.2252
Within Groups	0.018781	26	0.000722			
Total	0.024799	27				

TABLE 130: ANOVA Summary for Change in Average Utilities Cost of Group H3 ($/hl): 1995 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.005217	1	0.005217	0.064098	0.802124	4.2252
Within Groups	2.116051	26	0.081387			
Total	2.121268	27				

TABLE 131: ANOVA Summary for Change in Average Fuel, Oil, and Lube Cost of Group H3 ($/hl): 1995 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.008556	1	0.008556	0.100884	0.753308	4.2252
Within Groups	2.204959	26	0.084806			
Total	2.213515	27				

TABLE 132: ANOVA Summary for Change in Average Repairs Cost of Group H3 ($/hl): 1995 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.367095	1	1.367095	2.783083	0.107265	4.2252
Within Groups	12.77162	26	0.491216			
Total	14.13871	27				

TABLE 133: ANOVA Summary for Change in Average Insurance and Tax Cost of Group H3 ($/hl): 1995 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.073128	1	0.073128	0.502067	0.484898	4.2252
Within Groups	3.787005	26	0.145654			
Total	3.860133	27				

TABLE 134: ANOVA Summary for Change in Average Miscellaneous Costs of Group H3: 1995 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	4.091811	1	4.091811	1.430448	0.242485	4.2252
Within Groups	74.37329	26	2.860511			
Total	78.4651	27				

TABLE 135: ANOVA Summary for Change in Average Hired Labour Cost of Group H3 ($/hl): 1995 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	78.00679	1	78.00679	**22.25426***	7.09E-05	4.2252
Within Groups	91.13655	26	3.505252			
Total	169.1433	27				

TABLE 136: ANOVA Summary for Change in Average Family Labour Cost of Group H3 ($/hl): 1995 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	4.256224	1	4.256224	4.338983*	0.047225	4.2252
Within Groups	25.50409	26	0.980927			
Total	29.76032	27				

TABLE 137: ANOVA Summary for Change in Average Operator Labour Cost of Group H3 ($/hl): 1995 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.188683	1	0.188683	0.176714	0.677666	4.2252
Within Groups	27.76091	26	1.067727			
Total	27.94959	27				

TABLE 138: ANOVA Summary for Change in Average Rent Cost of Group H3 ($/hl): 1995 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.016519	1	0.016519	0.026201	0.872662	4.2252
Within Groups	16.39266	26	0.630487			
Total	16.40918	27				

TABLE 139: ANOVA Summary for Change in Average User Cost of Buildings of Group H3 ($/hl): 1995 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.0858202	1	0.858202	0.131423	0.719891	4.2252
Within Groups	169.7818	26	6.53007			
Total	170.64	27				

TABLE 140: ANOVA Summary for Change in Average User Cost of Machinery & Equipment of Group H3 ($/hl): 1995 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.673491	1	0.673491	0.5675	0.458022	4.2252
Within Groups	30.856	26	1.186769			
Total	31.5295	27				

TABLE 141: ANOVA Summary for Change in Average User Cost of Land of Group H3 ($/hl): 1995 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.000414	1	0.000414	0.007942	0.929669	4.2252
Within Groups	1.353889	26	0.052073			
Total	1.354302	27				

TABLE 142: ANOVA Summary for Change in Average User Cost of Dairy Herd of Group H3 ($/hl): 1995 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.321304	1	0.321304	**9.373342***	0.005065	4.2252
Within Groups	0.891242	26	0.034279			
Total	1.212546	27				

TABLE 143: ANOVA Summary for Change in Average Feed Cost of Group H3 ($/hl): 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	134.9605	1	134.9605	**13.0981***	0.001308	4.241699
Within Groups	257.5956	25	10.30383			
Total	392.5562	26				

TABLE 144: ANOVA Summary for Change in Average Processing Cost of Group H3 ($/hl): 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.003464	1	0.003464	0.796253	0.380725	4.241699
Within Groups	0.108768	25	0.004351			
Total	0.112233	26				

TABLE 145: ANOVA Summary for Change in Average Bedding and Supplies Cost of Group H3 ($/hl): 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.380063	1	0.380063	2.596576	0.11965	4.241699
Within Groups	3.659272	25	0.146371			
Total	4.039336	26				

TABLE 146: ANOVA Summary for Change in Average Breeding Cost of Group H3 ($/hl): 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.19609	1	0.19609	1.005852	0.325508	4.241699
Within Groups	4.873716	25	0.194949			
Total	5.069806	26				

TABLE 147: ANOVA Summary for Change in Average Vet and Medicine Cost of Group H3 ($/hl): 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.618968	1	0.618968	1.257561	0.27277	4.241699
Within Groups	12.30492	25	0.492197			
Total	12.92389	26				

TABLE 148: ANOVA Summary for Change in Average Milk Hauling Cost of Group H3 ($/hl): 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.04102	1	0.04102	1.285091	0.267709	4.241699
Within Groups	0.797992	25	0.03192			
Total	0.839012	26				

TABLE 149: ANOVA Summary for Change in Average Producer Fee of Group H3 ($/hl): 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.013739	1	0.013739	**13.84028***	0.001013	4.241699
Within Groups	0.024817	25	0.000993			
Total	0.038556	26				

TABLE 150: ANOVA Summary for Change in Average Utilities Cost of Group H3 ($/hl): 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.008973	1	0.008973	0.0655	0.8001	4.241699
Within Groups	3.424955	25	0.136998			
Total	3.433928	26				

TABLE 151: ANOVA Summary for Change in Average Fuel, Oil, and Lube Cost of Group H3 ($/hl): 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.008243	1	0.008243	0.092067	0.764076	4.241699
Within Groups	2.23828	25	0.089531			
Total	2.246523	26				

TABLE 152: ANOVA Summary for Change in Average Repairs Cost of Group H3 ($/hl): 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.00978	1	0.00978	0.012501	0.91187	4.241699
Within Groups	19.55941	25	0.782377			
Total	19.56919	26				

TABLE 153: ANOVA Summary for Change in Average Insurance and Tax Cost of Group H3 ($/hl): 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.052903	1	0.052903	0.330116	0.570725	4.241699
Within Groups	4.006372	25	0.160255			
Total	4.059275	26				

TABLE 154: ANOVA Summary for Change in Average Miscellaneous Costs of Group H3 ($/hl): 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	3.78152	1	3.78152	1.85295	0.18566	4.241699
Within Groups	51.03832	25	2.041533			
Total	54.81984	26				

TABLE 155: ANOVA Summary for Change in Average Hired Labour Cost of Group H3 ($/hl): 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	68.43501	1	68.43501	**18.30623***	0.000242	4.241699
Within Groups	93.45865	25	3.738346			
Total	161.8937	26				

TABLE 156: ANOVA Summary for Change in Average Family Labour Cost of Group H3 ($/hl): 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	6.504188	1	6.504188	6.480433*	0.017451	4.241699
Within Groups	25.09164	25	1.003666			
Total	31.59583	26				

TABLE 157: ANOVA Summary for Change in Average Operator Labour Cost of Group H3 ($/hl): 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.110784	1	0.110784	0.144551	0.707069	4.241699
Within Groups	19.16004	25	0.766402			
Total	19.27083	26				

TABLE 158: ANOVA Summary for Change in Average Rent Cost of Group H3 ($/hl): 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.425257	1	0.953504	0.953504	0.338184	4.241699
Within Groups	11.14985	25	0.445994			
Total	11.5751	26				

TABLE 159: ANOVA Summary for Change in Average User Cost of Buildings of Group H3 ($/hl): 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	6.437057	1	6.437057	1.03788	0.318073	4.241699
Within Groups	155.0531	25	6.202123			
Total	161.4901	26				

TABLE 160: ANOVA Summary for Change in Average User Cost of Machinery & Equipment of Group H3 ($/hl): 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.0057	1	0.0057	0.004879	0.944868	4.241699
Within Groups	29.20425	25	1.16817			
Total	2920995	26				

TABLE 161: ANOVA Summary for Change in Average User Cost of Land of Group H3 ($/hl): 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.065306	1	0.065306	1.009855	0.324566	4.241699
Within Groups	1.616719	25	0.064669			
Total	1.682025	26				

TABLE 162: ANOVA Summary for Change in Average User Cost of Dairy Herd of Group H3 ($/hl): 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.551353	1	0.551353	**10.15489***	0.003839	4.241699
Within Groups	1.357358	25	0.054294			
Total	1.908711	26				

APPENDIX E

ANOVA Summary for Average Dairy Economic Costs of Production

Milk Yield Distribution of Data

TABLE 1: ANOVA Summary for 1996 Average Feed Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	13.77933	2	6.889665	0.547499	0.581354	3.155932
Within Groups	729.8651	58	12.58388			
Total	743.6444	60				

TABLE 2: ANOVA Summary for 1996 Average Processing Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.315187	2	0.157594	2.707701	0.075121	3.155932
Within Groups	3.375718	58	0.058202			
Total	3.690905	60				

TABLE 3: ANOVA Summary for 1996 Average Bedding and Supplies Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.013634	2	0.506817	1.071155	0.349292	3.155932
Within Groups	27.4427	58	0.47315			
Total	28.45634	60				

TABLE 4: ANOVA Summary for 1996 Average Breeding Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.038168	2	0.019084	0.12643	0.881478	3.155932
Within Groups	8.754807	58	0.150945			
Total	8.792975	60				

TABLE 5: ANOVA Summary for 1996 Average Veterinary and Medicine Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.13164	2	0.06582	0.12643	0.881478	3.155932
Within Groups	30.19515	58	0.520606			
Total	30.32679	60				

TABLE 6: ANOVA Summary for 1996 Average Milk Hauling Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.03405	2	0.017025	0.766529	0.469272	3.155932
Within Groups	1.288209	58	0.022211			
Total	1.322259	60				

TABLE 7: ANOVA Summary for 1996 Average Producer Fee ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.005953	2	0.002977	3.372729*	0.041147	3.155932
Within Groups	0.051189	58	0.000883			
Total	0.057142	69				

TABLE 8: ANOVA Summary for 1996 Average Producer Fee ($/hl): Groups M1 and M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.0028	1	0.0028	2.936659	0.094529	4.091277
Within Groups	0.037183	39	0.000953			
Total	0.039983	40				

TABLE 9: ANOVA Summary for 1996 Average Producer Fee ($/hl): Groups M1 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.00571	1	0.00571	8.715666*	0.005452	4.105459
Within Groups	0.024241	37	0.000655			
Total	0.029951	38				

TABLE 10: ANOVA Summary for 1996 Average Producer Fee ($/hl): Groups M2 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.000611	1	0.000611	0.596723	0.444372	4.08474
Within Groups	0.040953	40	0.001024			
Total	0.041564	41				

TABLE 11: ANOVA Summary for 1996 Average Utilities Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.304944	2	0.152472	0.950395	0.393535	3.155932
Within Groups	9.304951	58	0.16043			
Total	9.609895	60				

TABLE 12: ANOVA Summary for 1996 Average Fuel, Oil, and Lube Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.831804	2	0.415902	2.361808	0.103255	3.155932
Within Groups	10.21349	58	0.176095			
Total	11.04529	60				

TABLE 13: ANOVA Summary for 1996 Average Rent Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.742668	2	0.871334	0.654487	0.523504	3.155932
Within Groups	77.21681	58	1.331324			
Total	78.95948	60				

TABLE 14: ANOVA Summary for 1996 Average Miscellaneous Costs ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	4.799807	2	2.399904	1.177582	0.315278	3.155932
Within Groups	118.2036	58	2.037994			
Total	123.0034	60				

TABLE 15: ANOVA Summary for 1996 Average Hired Labour Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	9.041311	2	4.520656	0.8276	0.442192	3.155932
Within Groups	316.8172	58	5.462365			
Total	325.8585	60				

TABLE 16: ANOVA Summary for 1996 Average Unpaid Family Labour Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	3.195687	2	1.597844	0.459031	0.634171	3.155932
Within Groups	201.8925	58	3.480906			
Total	205.0882	60				

TABLE 17: ANOVA Summary for 1996 Average Operator Labour Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	58.15373	2	29.07686	2.88855	0.063699	3.155932
Within Groups	583.8426	58	10.06625			
Total	641.9963	60				

TABLE 18: ANOVA Summary for 1996 Average Insurance & Tax Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.017905	2	0.008952	0.053137	0.948296	3.155932
Within Groups	9.771537	58	0.168475			
Total	9.789442	60				

TABLE 19: ANOVA Summary for 1996 Average Repairs Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.210462	2	0.605231	0.705077	0.498255	3.155932
Within Groups	49.78661	58	0.85839			
Total	50.99707	60				

TABLE 20: ANOVA Summary for 1996 Average User Cost of Buildings ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	17.0309	2	8.515449	1.358241	0.265168	3.155932
Within Groups	363.6601	58	6.269469			
Total	380.6601	60				

TABLE 21: ANOVA Summary for 1996 Average User Cost of Machinery &Equipment ($/hl): Groups M1, M2,M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	17.9532	1	17.9532	**5.328128***	0.026374	4.091277
Within Groups	131.411	39	3.369513			
Total	149.3642	40				

TABLE 22: ANOVA Summary for 1996 Average User Cost of Machinery & Equipment ($/hl): Groups M1,M2,M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	17.9532	1	17.9532	**5.328128***	0.026374	4.091277
Within Groups	131.411	39	3.369513			
Total	149.3642	40				

TABLE 23: ANOVA Summary for 1996 Average User Cost of Machinery & Equipment ($/hl): Groups M1 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	13.71979	1	13.71979	3.499845	0.0693	4.105459
Within Groups	145.0442	37	3.920113			
Total	158.764	38				

TABLE 24: ANOVA Summary for 1996 Average User Cost of Machinery & Equipment ($/hl): Groups M2 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.206463	1	0.206463	0.109416	0.742536	4.08474
Within Groups	75.47801	40	1.88695			
Total	75.68447	41				

TABLE 25: ANOVA Summary for 1996 Average User Cost of Land ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.482398	2	0.241199	1.130891	0.329758	3.155932
Within Groups	12.37039	58	0.213283			
Total	12.85278	60				

TABLE 26: ANOVA Summary for 1996 Average User Cost of Dairy Herd ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.551411	2	0.275705	**13.63265***	1.4E-05	3.155932
Within Groups	1.172986	58	0.020224			
Total	1.724397	60				

TABLE 27: ANOVA Summary for 1996 Average User Dairy Herd ($/hl): Groups M1 and M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.089742	1	0.089742	**4.553317***	0.0392	4.091277
Within Groups	0.768656	39	0.019709			
Total	0.858398	40				

TABLE 28: ANOVA Summary for 1996 Average User Dairy Herd ($/hl): Groups M1 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.541133	1	0.541133	**22.88941***	2.74E-05	4.105459
Within Groups	0.874723	37	0.023641			
Total	1.415856	38				

TABLE 29: ANOVA Summary for 1996 Average User Dairy Herd ($/hl): Groups M2 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.210773	1	0.210773	**11.9997***	0.001283	4.08474
Within Groups	0.702593	40	0.017565			
Total	0.913366	41				

TABLE 30: ANOVA Summary for 1996 Average Total Variable Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	9.142718	2	4.571359	0.278909	0.757618	3.155932
Within Groups	950.6292	58	16.39016			
Total	959.7719	60				

TABLE 31: ANOVA Summary for 1996 Average Total Labour Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	101.1716	2	50.58582	8.637717*	0.000521	3.155932
Within Groups	339.6705	58	5.856388			
Total	440.8421	60				

TABLE 32: ANOVA Summary for 1996 Average Total Labour Cost ($/hl): Groups M1 and M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	57.87327	1	57.87327	8.404548*	0.006116	4.091277
Within Groups	268.5519	39	6.885947			
Total	326.4252	40				

TABLE 33: ANOVA Summary for 1996 Average Total Labour Cost ($/hl): Groups M1 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	92.02101	1	92.02101	15.01323*	0.000421	4.105459
Within Groups	226.7852	37	6.129329			
Total	318.8062	38				

TABLE 34: ANOVA Summary for 1996 Average Total Labour Cost ($/hl): Groups M2 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	4.996357	1	4.996357	1.086142	0.303586	4.08474
Within Groups	184.0039	40	4.600097			
Total	189.0003	41				

TABLE 35: ANOVA Summary for 1996 Average Total Costs of Production ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	319.8509	2	159.9255	4.05541*	0.022465	3.155932
Within Groups	2287.235	58	39.43509			
Total	2607.086	60				

TABLE 36: ANOVA Summary for 1995 Average Feed Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	18.98134	2	9.49067	1.489981	0.233089	3.140443
Within Groups	407.658	64	6.369657			
Total	426.6394	66				

TABLE 37: ANOVA Summary for 1995 Average Processing Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.086821	2	0.043411	0.640854	0.530189	3.140443
Within Groups	4.335273	64	0.067739			
Total	4.422094	66				

TABLE 38: ANOVA Summary for 1995 Average Bedding and Supplies Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.910812	2	0.955406	2.280865	0.110444	3.140443
Within Groups	26.80824	64	0.418879			
Total	28.71906	66				

TABLE 39: ANOVA Summary for 1995 Average Breeding Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.207316	2	0.103658	0.442754	0.644217	3.140443
Within Groups	14.98375	64	0.234121			
Total	15.19107	66				

TABLE 40: ANOVA Summary for 1995 Average Veterinary and Medicine Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.945799	2	0.9729	**4.214286***	0.019083	3.140443
Within Groups	14.77488	64	0.230858			
Total	16.72068	66				

TABLE 41: ANOVA Summary for 1995 Average Veterinary and Medicine Cost ($/hl): Groups M1 and M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.484506	1	1.484506	**5.54282***	0.022526	4.03432
Within Groups	13.39126	50	0.267825			
Total	14.87576	51				

TABLE 42: ANOVA Summary for 1995 Average Veterinary and Medicine Cost ($/hl): Groups M1 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.002531	1	0.002531	0.011929	0.913618	4.105459
Within Groups	7.849061	37	0.212137			
Total	7.851591	38				

TABLE 43: ANOVA Summary for 1995 Average Veterinary and Medicine Cost ($/hl): Groups M2 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.234314	1	1.234314	**6.090284***	0.017856	4.078544
Within Groups	8.309445	41	0.202669			
Total	9.543759	42				

TABLE 44: ANOVA Summary for 1995 Average Milk Hauling Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.056084	2	0.028042	2.232186	0.115582	3.140443
Within Groups	0.804007	64	0.012563			
Total	0.860092	66				

TABLE 45: ANOVA Summary for 1995 Average Producer Fee ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.000809	2	0.000404	0.180311	0.835433	3.140443
Within Groups	1.43496	64	0.002242			
Total	0.144305	66				

TABLE 46: ANOVA Summary for 1995 Average Milk Hauling Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.398998	2	0.199499	0.721951	0.489717	3.140443
Within Groups	17.6853	64	0.276333			
Total	18.08429	66				

TABLE 47: ANOVA Summary for 1995 Average Fuel, Oil, and Lube Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.181157	2	0.090578	0.50387	0.606564	3.140443
Within Groups	11.50497	64	0.179765			
Total	11.68613	66				

TABLE 48: ANOVA Summary for 1995 Average Rent Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.435064	2	0.217532	0.773718	0.465561	3.140443
Within Groups	17.99371	64	0.281152			
Total	18.42878	66				

TABLE 49: ANOVA Summary for 1995 Average Miscellaneous Costs ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.698803	2	0.349402	0.225212	0.798977	3.140443
Within Groups	99.29171	64	1.551433			
Total	99.9051	66				

TABLE 50: ANOVA Summary for 1995 Average Hired Labour Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.406363	2	0.703182	0.186455	0.8303455	3.140443
Within Groups	241.3643	64	3.771317			
Total	242.7707	66				

TABLE 51: ANOVA Summary for 1995 Average Unpaid Family Labour Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	18.11801	2	9.059003	2.222663	0.116616	3.140443
Within Groups	260.8475	64	4.075742			
Total	278.9655	66				

TABLE 52: ANOVA Summary for 1995 Average Operator Labour Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	41.39826	2	20.69913	1.936156	0.152614	3.140443
Within Groups	684.2135	64	10.69084			
Total	725.6118	66				

TABLE 53: ANOVA Summary for 1995 Average Insurance & Tax Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.461235	2	0.230618	1.313856	0.275932	3.140443
Within Groups	11.23375	64	0.175527			
Total	11.69498	66				

TABLE 54: ANOVA Summary for 1995 Average Repairs Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.005306	2	0.002653	0.002112	0.99789	3.140443
Within Groups	80.38123	64	1.255957			
Total	80.38654	66				

TABLE 55: ANOVA Summary for 1995 Average User Cost of Buildings ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	15.78687	2	7.893436	1.491175	0.232824	3.140443
Within Groups	338.7799	64	5.293435			
Total	354.5667	66				

TABLE 56: ANOVA Summary for 1995 Average User Cost of Machinery &Equipment ($/hl): Groups M1, M2, M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	35.14949	2	17.57475	7.132328*	0.001598	3.140443
Within Groups	157.7022	64	2.464097			
Total	192.8517	66				

TABLE 57: ANOVA Summary for 1995 Average User Cost of Machinery & Equipment ($/hl): Groups M1 and M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	30.65087	1	30.65087	13.66607*	0.000542	4.03432
Within Groups	112.1422	50	2.242844			
Total	142.7931	51				

TABLE 58: ANOVA Summary for 1995 Average User Cost of Machinery & Equipment ($/hl): Groups M1 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.397971	1	0.397971	0.136022	0.71437	4.105459
Within Groups	108.2538	37	2.925778			
Total	108.6517	38				

TABLE 59: ANOVA Summary for 1995 Average User Cost of Machinery & Equipment ($/hl): Groups M2 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	17.34069	1	17.34069	7.483214*	0.00916	4.078544
Within Groups	95.0084	41	2.317278			
Total	112.3491	42				

TABLE 60: ANOVA Summary for 1995 Average User Cost of Land ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.363449	2	0.181725	0.548841	0.580313	3.140443
Within Groups	21.19079	64	0.331106			
Total	21.55424	66				

TABLE 61: ANOVA Summary for 1995 Average User Cost of Dairy Herd ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.399243	2	0.199621	**7.8387***	0.000902	3.140443
Within Groups	1.629832	64	0.025466			
Total	2.029075	66				

TABLE 62: ANOVA Summary for 1995 Average User Cost of Dairy Herd ($/hl): Groups M1 and M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.163716	1	0.163716	**6.140181***	0.016636	4.03432
Within Groups	1.333154	50	0.026663			
Total	1.49687	51				

TABLE 63: ANOVA Summary for 1995 Average User Cost of Dairy Herd ($/hl): Groups M1 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.3798	1	0.3798	**12.83953***	0.000973	4.105459
Within Groups	1.094481	37	0.029581			
Total	1.474281	38				

TABLE 64: ANOVA Summary for 1995 Average User Cost of Dairy Herd ($/hl): Groups M2 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.079623	1	0.079623	3.923606	0.054348	4.078544
Within Groups	0.83203	41	0.020293			
Total	0.911653	42				

TABLE 65: ANOVA Summary for 1995 Average Total Variable Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	6.09178	2	3.04589	0.24807	0.781052	3.140443
Within Groups	785.8154	64	12.27837			
Total	791.9072	66				

TABLE 66: ANOVA Summary for 1995 Average Total Labour Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	137.9168	2	68.95838	2.267843	0.111795	3.140443
Within Groups	1946.05	64	30.40704			
Total	2083.967	66				

TABLE 67: ANOVA Summary for 1995 Average Total Costs of Production ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	519.167	2	259.5835	**4.052744***	0.022018	3.140443
Within Groups	4099.282	64	64.05128			
Total	4618.449	66				

TABLE 68: ANOVA Summary for 1994 Average Feed Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	15.46361	2	7.731807	0.766822	0.468295	3.125763
Within Groups	715.8876	71	10.08292			
Total	731.3512	73				

TABLE 69: ANOVA Summary for 1994 Average Processing Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.238483	2	0.119241	2.884672	0.062446	3.125763
Within Groups	2.934869	71	0.041336			
Total	3.173352	73				

TABLE 70: ANOVA Summary for 1994 Average Bedding and Supplies Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.117898	2	0.058949	0.082229	0.921149	3.125763
Within Groups	50.89919	71	0.71689			
Total	51.01708	73				

TABLE 71: ANOVA Summary for 1994 Average Breeding Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.132386	2	0.066193	0.178043	0.837279	3.125763
Within Groups	26.39638	71	0.37178			
Total	26.52877	73				

TABLE 72: ANOVA Summary for 1994 Average Veterinary and Medicine Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.627073	2	0.313537	0.787633	0.458854	3.125763
Within Groups	28.26329	71	0.398074			
Total	28.89036	73				

TABLE 73: ANOVA Summary for 1994 Average Milk Hauling Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.056103	2	0.028051	1.293711	0.280636	3.125763
Within Groups	1.539481	71	0.021683			
Total	1.595584	73				

TABLE 74: ANOVA Summary for 1994 Average Producer Fee ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.05888	2	0.02944	1.856742	0.163684	3.125763
Within Groups	1.125766	71	0.015856			
Total	1.184646	73				

TABLE 75: ANOVA Summary for 1994 Average Utilities Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.468796	2	0.234398	1.08725	0.342689	3.125763
Within Groups	15.30674	71	0.215588			
Total	15.77554	73				

TABLE 76: ANOVA Summary for 1994 Average Fuel, Oil, and Lube Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.272137	2	0.136068	0.908468	0.407775	3.215763
Within Groups	10.63423	71	0.149778			
Total	10.90637	73				

TABLE 77: ANOVA Summary for 1994 Average Rent Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.4414	2	0.2207	1.038537	0.359286	3.125763
Within Groups	15.08826	71	0.212511			
Total	15.52966	73				

TABLE 78: ANOVA Summary for 1994 Average Miscellaneous Costs ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.386715	2	0.693358	0.658703	0.520656	3.125763
Within Groups	74.73536	71	1.052611			
Total	76.12208	73				

TABLE 79: ANOVA Summary for 1994 Average Hired Labour Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	25.8979	2	12.94895	2.945141	0.059052	3.125763
Within Groups	312.1668	71	4.396716			
Total	338.0647	73				

TABLE 80: ANOVA Summary for 1994 Average Unpaid Family Labour Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	12.84965	2	6.424824	1.597301	0.20963	3.125763
Within Groups	285.5834	71	4.022301			
Total	298.433	73				

TABLE 81: ANOVA Summary for 1994 Average Operator Labour Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	23.34103	2	11.67051	1.654473	0.198478	3.125763
Within Groups	500.8279	71	7.053915			
Total	524.169	73				

TABLE 82: ANOVA Summary for 1994 Average Insurance & Tax Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.107106	2	0.053553	0.382888	0.683288	3.125763
Within Groups	9.93048	71	0.139866			
Total	10.03759	73				

TABLE 83: ANOVA Summary for 1994 Average Repairs Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.137134	2	0.568567	0.369737	0.692238	3.125763
Within Groups	109.1809	71	1.53776			
Total	110.3181	73				

TABLE 84: ANOVA Summary for 1994 Average User Cost of Building ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	9.441775	2	4.720887	0.781747	0.461504	3.125763
Within Groups	428.7614	71	6.038894			
Total	438.2032	73				

TABLE 85: ANOVA Summary for 1994 Average User Cost of Machinery & Equipment ($/hl): Groups M1, M2, M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	19.50461	2	9.752307	2.985924	0.056871	3.125763
Within Groups	231.8927	71	3.266094			
Total	251.3973	73				

TABLE 86: ANOVA Summary for 1994 Average User Cost of Land ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2.786292	2	1.393146	2.95958	0.05827	3.125763
Within Groups	33.42142	71	0.470724			
Total	36.20772	73				

TABLE 87: ANOVA Summary for 1994 Average User Cost of Dairy Herd ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.877334	2	0.438667	**10.4922***	0.000102	3.125763
Within Groups	2.968428	71	0.041809			
Total	3.845762	73				

TABLE 88: ANOVA Summary for 1994 Average User Cost of Dairy Herd ($/hl): Groups M1 and M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.40794	1	0.40794	**10.12118***	0.002495	4.030397
Within Groups	2.055587	51	0.040306			
Total	2.463527	52				

TABLE 89: ANOVA Summary for 1994 Average User Cost of Dairy Herd ($/hl): Groups M1 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.770063	1	0.770063	**15.26424***	0.000271	4.026631
Within Groups	2.623341	52	0.050449			
Total	3.393405	53				

TABLE 90: ANOVA Summary for 1994 Average User Cost of Dairy Herd ($/hl): Groups M2 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.041913	1	0.041913	1.29949	0.261267	4.091277
Within Groups	1.257929	39	0.032255			
Total	1.299842	40				

TABLE 91: ANOVA Summary for 1994 Average Total Variable Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	24.02562	2	12.01281	0.754546	0.473957	3.125763
Within Groups	1130.362	71	15.92059			
Total	1154.387	73				

TABLE 92: ANOVA Summary for 1994 Average Total Labour Cost ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	73.00305	2	36.50153	1.440003	0.243762	3.125763
Within Groups	1799.725	71	25.34824			
Total	1872.728	73				

TABLE 93: ANOVA Summary for 1994 Average Total Costs of Production ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	176.2055	2	88.10276	1.353951	0.264803	3.125763
Within Groups	4620.03	71	65.07085			
Total	4796.236	73				

TABLE 94: ANOVA Summary for Average Total Cost of Production of Group M1 ($/hl): 1994 - 1995

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	54.38543	1	54.38543	0.655326	0.421703	4.016186
Within Groups	4564.442	55	82.98985			
Total	4618.827	56				

TABLE 95: ANOVA Summary for Average Total Cost of Production of Group M1 ($/hl): 1995 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.000391	1	0.000391	5.98E-06	0.998061	4.078544
Within Groups	2679.485	41	65.3533			
Total	2679.486	42				

TABLE 96: ANOVA Summary for Average Total Cost of Production of Group M1 ($/hl): 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	46.90589	1	46.90589	0.650683	0.423689	4.03432
Within Groups	3604.36	50	72.0872			
Total	3651.266	51				

TABLE 97: ANOVA Summary for Average Total Cost of Production of Group M2 ($/hl): 1994 - 1995

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	5.350823	1	5.350823	0.125857	0.724388	4.051742
Within Groups	1955.696	46	42.51512			
Total	1961.046	47				

TABLE 98: ANOVA Summary for Average Total Cost of Production of Group M2 ($/hl): 1995 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	69.42305	1	69.42305	1.564545	0.217064	4.042647
Within Groups	2129.889	48	44.37268			
Total	2199.312	49				

TABLE 99: ANOVA Summary for Average Total Cost of Production of Group M2 ($/hl): 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	30.15456	1	30.15456	0.960349	0.332989	4.08474
Within Groups	1255.984	40	31.39959			
Total	1286.138	41				

TABLE 100: ANOVA Summary for Average Total Cost of Production of Group M3 ($/hl): 1994 - 1995

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2.280369	1	2.280369	0.035255	0.852178	4.130015
Within Groups	2199.175	34	64.68162			
Total	2201.456	35				

TABLE 101: ANOVA Summary for Average Total Cost of Production of Group M3 ($/hl): 1995 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	8.852663	1	8.852663	0.16867	0.683545	4.091277
Within Groups	2046.922	39	52.48517			
Total	2055.774	40				

TABLE 102: ANOVA Summary for Average Total Cost of Production of Group M3 ($/hl): 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	8.852663	1	8.852663	0.16867	0.683545	4.091277
Within Groups	2046.922	39	52.48517			
Total	2055.774	40				

APPENDIX F

ANOVA Summary for Average Physical Efficiency

Herd Size Distribution of Data

TABLE 1: ANOVA Summary for 1996 Average Labour Productivity (cows/worker): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2421.847	2	1210.923	22.32294*	2.03E-07	3.20928
Within Groups	2386.81	44	54.24569			
Total	4808.657	46				

TABLE 2: ANOVA Summary for 1996 Average Labour Productivity (cows/worker): Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.377398	1	0.377398	0.017281	0.896265	4.159617
Within Groups	677.0254	31	21.83953			
Total	677.4028	32				

TABLE 3: ANOVA Summary for 1996 Average Labour Productivity (cows/worker): Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1488.351	1	1488.351	17.33112*	0.000375	4.279343
Within Groups	1975.18	23	85.87738			
Total	3463.531	24				

TABLE 4: ANOVA Summary for 1996 Average Labour Productivity (cows/worker): Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2127.932	1	2127.932	34.10444*	1.39E-06	4.130015
Within Groups	2121.416	34	62.39458			
Total	4249.348	35				

TABLE 5: ANOVA Summary for 1995 Average Labour Productivity (cows/worker): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1546.237	2	773.1184	13.30565*	2.89E-05	3.20432
Within Groups	2614.703	45	58.10452			
Total	4160.94	47				

TABLE 6: ANOVA Summary for 1995 Average Labour Productivity (cows/worker): Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	133.2502	1	133.2502	3.354784	0.076333	4.149086
Within Groups	1271.023	32	39.71946			
Total	1404.273	33				

TABLE 7: ANOVA Summary for 1995 Average Labour Productivity (cows/worker): Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1432.014	1	1432.014	**16.78121***	0.000363	4.2252
Within Groups	2218.694	26	85.33438			
Total	3650.708	27				

TABLE 8: ANOVA Summary for 1995 Average Labour Productivity (cows/worker): Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	870.3663	1	870.3663	**16.00959***	0.000349	4.149086
Within Groups	1739.69	32	54.36532			
Total	2610.056	33				

TABLE 9: ANOVA Summary for 1994 Average Labour Productivity (cows/worker): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1508.581	2	754.2906	**7.998419***	0.000952	3.178798
Within Groups	4809.553	51	94.30497			
Total	6318.134	53				

TABLE 10: ANOVA Summary for 1994 Average Labour Productivity (cows/worker): Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	5.29E-05	1	5.29E-05	9.85E-07	0.999213	4.098169
Within Groups	2039.355	38	53.66724			
Total	2039.355	39				

TABLE 11: ANOVA Summary for 1994 Average Labour Productivity (cows/worker): Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1086.432	1	1086.432	**8.073723***	0.008283	4.195982
Within Groups	3767.79	28	134.5639			
Total	4854.222	29				

TABLE 12: ANOVA Summary for 1994 Average Labour Productivity (cows/worker): Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1286.064	1	1286.064	**12.14553***	0.001313	4.113161
Within Groups	3811.961	36	105.8878			
Total	5098.025	37				

TABLE 13: ANOVA Summary for 1996 Average Milk Productivity (hl/cow): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	575.7908	2	287.8954	0.5823894	0.561717	3.195055
Within Groups	23173.89	47	493.0615			
Total	23749.68	49				

TABLE 14: ANOVA Summary for 1995 Average Milk Productivity (hl/cow): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	32.64385	2	16.32193	0.124488	0.883252	3.20432
Within Groups	5900.051	45	131.1123			
Total	5932.695	47				

TABLE 15: ANOVA Summary for 1994 Average Milk Productivity (hl/cow): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	558.8698	2	279.4349	2.161677	0.126211	3.190721
Within Groups	6204.846	48	129.2672			
Total	6763.715	50				

APPENDIX G

ANOVA Summary for Average Physical Efficiency
Milk Yield Distribution of Data

TABLE 1: ANOVA Summary for 1996 Average Labour Productivity (cows/worker): Groups M1, M2, M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.167685	2	0.083843	0.000887	0.999114	3.155932
Within Groups	5483.335	58	94.54026			
Total	5483.503	60				

TABLE 2: ANOVA Summary for 1995 Average Labour Productivity (cows/worker): Groups M1, M2, M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	94.4108	2	47.2054	0.506102	0.605233	3.140443
Within Groups	5969.445	64	93.27259			
Total	6063.856	66				

TABLE 3: ANOVA Summary for 1994 Average Labour Productivity (cows/worker): Groups M1, M2, M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	365.4999	2	182.75	1.318745	0.273941	3.125763
Within Groups	9839.087	71	138.5787			
Total	10204.59	73				

TABLE 4: ANOVA Summary for 1996 Average Milk Productivity (hl/cow): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	4736.831	2	2368.416	**98.57485***	2.2E-19	3.155932
Within Groups	1393.541	58	24.0657			
Total	6130.372	60				

TABLE 5: ANOVA Summary for 1996 Average Milk Productivity (hl/cow): Groups M1 and M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1377.568	1	1377.568	**53.18669***	8.52E-09	4.091277
Within Groups	1010.124	39	25.90062			
Total	2387.692	40				

TABLE 6: ANOVA Summary for 1996 Average Milk Productivity (hl/cow): Groups M1 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	4735.402	1	4735.402	**140.2504***	3.76E-14	4.105459
Within Groups	1249.265	37	33.76391			
Total	5984.666	38				

TABLE 7: ANOVA Summary for 1996 Average Milk Productivity (hl/cow): Groups M2 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1137.756	1	1137.756	**86.24367***	1.56E-11	4.08474
Within Groups	527.6936	40	13.19234			
Total	1665.449	41				

TABLE 8: ANOVA Summary for 1995 Average Milk Productivity (hl/cow): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	6534.662	2	3267.331	**165.1254***	5.41E-26	3.140443
Within Groups	1266.366	64	19.78696			
Total	7801.028	66				

TABLE 9: ANOVA Summary for 1995 Average Milk Productivity (hl/cow): Groups M1 and M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2991.377	1	2991.377	**139.6037***	4.38E-16	4.03432
Within Groups	1071.381	50	21.42763			
Total	4062.758	51				

TABLE 10: ANOVA Summary for 1995 Average Milk Productivity (hl/cow): Groups M1 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	6067.553	1	6067.553	**206.175***	1.05E-16	4.105459
Within Groups	1088.879	37	29.42915			
Total	7156.432	38				

TABLE 11: ANOVA Summary for 1995 Average Milk Productivity (hl/cow): Groups M2 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1061.307	1	1061.307	**116.8239***	1.43E-13	4.078544
Within Groups	372.4716	41	9.084673			
Total	1433.779	42				

TABLE 12: ANOVA Summary for 1994 Average Milk Productivity (hl/cow): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	8248.364	2	4124.182	**158.6232***	6.4E-27	3.125763
Within Groups	1845.99	71	25.99986			
Total	10094.35	73				

TABLE 13: ANOVA Summary for 1994 Average Milk Productivity (hl/cow): Groups M1 and M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2424.733	1	102.8906	**102.8906***	7.92E-14	4.030397
Within Groups	1201.873	51	23.56614			
Total	3626.606	52				

TABLE 14: ANOVA Summary for 1994 Average Milk Productivity (hl/cow): Groups M1 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	7984.26	1	7984.26	**240.6253***	3.75E-21	4.026631
Within Groups	1725.428	52	33.1813			
Total	9709.687	53				

TABLE 15: ANOVA Summary for 1994 Average Milk Productivity (hl/cow): Groups M2 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1237.026	1	1237.026	**63.09043***	1.13E-09	4.091277
Within Groups	764.6801	39	19.60718			
Total	2001.706	40				

APPENDIX H

ANOVA Summary for Average Cost Efficiency
Herd Size Distribution of Data

TABLE 1: ANOVA Summary for 1996 Average Feed Cost Control Ratio: Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.006818	2	0.003409	0.820558	0.446808	3.20928
Within Groups	0.182798	44	0.004154			
Total	0.189613	46				

TABLE 2: ANOVA Summary for 1996 Average Total Labour Cost Control Ratio: Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Group	0.031937	2	0.015968	**9.35916***	0.00041	3.20928
Within Groups	0.075072	44	0.001706			
Total	0.107009	46				

TABLE 3: ANOVA Summary for 1996 Average Total Labour Cost Control Ratio: Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.001748	1	0.001748	0.980754	0.32968	4.159617
Within Groups	0.055254	31	0.001782			
Total	0.057003	32				

TABLE 4: ANOVA Summary for 1996 Average Total Labour Cost Control Ratio: Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.026598	1	0.026598	**16.67595***	0.000457	4.279343
Within Groups	0.036685	23				
Total	0.063284	24				

TABLE 5: ANOVA Summary for 1996 Average Total Labour Cost Control Ratio: Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Group	0.021622	1	0.021622	**12.63037***	0.001138	4.130015
Within Groups	0.058204	34	0.001712			
Total	0.079826	35				

TABLE 6: ANOVA Summary for 1996 Average User Cost of Capital Control Ratio: Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.00035	2	0.00175	0.050811	0.950514	3.20928
Within Groups	0.15166	44	0.003447			
Total	0.152011	46				

TABLE 7: ANOVA Summary for 1996 Average Total Production Cost Control Ratio: Groups H1, H2, H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.069977	2	0.034988	2.822621	0.070251	3.20928
Within Groups	0.54541	44	0.012396			
Total	0.615386	46				

TABLE 8: ANOVA Summary for 1995 Average Feed Cost Control Ratio: Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.000299	2	0.00015	0.038385	0.962374	3.20432
Within Groups	0.175263	45	0.003895			
Total	0.175562	47				

TABLE 9: ANOVA Summary for 1995 Average Total Labour Cost Control Ratio: Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.303139	2	0.151569	**19.39065***	8.44E-07	3.20432
Within Groups	0.351748	45	0.007817			
Total	0.654887	47				

TABLE 10: ANOVA Summary for 1995 Average Total Labour Cost Control Ratio: Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.014437	1	0.014437	1.526669	0.225607	4.149086
Within Groups	0.302613	32	0.009457			
Total	0.317051	33				

TABLE 11: ANOVA Summary for 1995 Average Total Labour Cost Control Ratio: Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.266869	1	0.266869	**25.06015***	3.31E-05	4.2252
Within Groups	0.276878	26	0.010649			
Total	0.543747	27				

TABLE 12: ANOVA Summary for 1995 Average Total Labour Cost Control Ratio: Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.193749	1	0.193749	**49.99759***	5.09E-08	4.149086
Within Groups	0.124005	32	0.003875			
Total	0.317755	33				

TABLE 13: ANOVA Summary for 1995 Average User Cost of Capital Control Ratio: Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.00484	2	0.00242	0.581338	0.563294	3.20432
Within Groups	0.187317	45	0.004163			
Total	0.192157	47				

TABLE 14: ANOVA Summary for 1995 Average Total Production Cost Control Ratio: Groups H1, H2, H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.4047	2	0.20235	**5.431812***	0.007707	3.20432
Within Groups	1.676372	45	0.037253			
Total	2.081072	47				

TABLE 15: ANOVA Summary for 1995 Average Total Production Cost Control Ratio: Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.000412	1	0.000412	0.00958	0.92264	4.149086
Within Groups	1.377708	32	0.043053			
Total	1.378121	33				

TABLE 16: ANOVA Summary for 1995 Average Total Production Cost Control Ratio: Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.297268	1	0.297268	**8.791865***	0.006405	4.2252
Within Groups	0.879104	26	0.033812			
Total	1.176372	27				

TABLE 17: ANOVA Summary for 1995 Average Total Production Cost Control Ratio: Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.326119	1	0.326119	**9.522318***	0.004167	4.149086
Within Groups	1.095932	32	0.034248			
Total	1.422051	33				

TABLE 18: ANOVA Summary for 1994 Average Feed Cost Control Ratio: Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.001318	2	0.000659	0.096802	0.907913	3.190721
Within Groups	0.326725	48	0.006807			
Total	0.328043	50				

TABLE 19: ANOVA Summary for 1994 Average Total Labour Cost Control Ratio: Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.327901	2	0.16395	**18.63862***	1.02E-06	3.190721
Within Groups	0.422221	48	0.008796			
Total	0.750122	50				

TABLE 20: ANOVA Summary for 1994 Average Total Labour Cost Control Ratio: Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.052209	1	0.052209	**4.864351***	0.033888	4.113161
Within Groups	0.386391	36	0.010733			
Total	0.4368	37				

TABLE 21: ANOVA Summary for 1994 Average Total Labour Cost Control Ratio: Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.320745	1	0.32745	**27.53828***	1.75E-05	4.2252
Within Groups	0.302828	26	0.011647			
Total	0.623573	27				

TABLE 22: ANOVA Summary for 1994 Average Total Labour Cost Control Ratio: Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.159948	1	0.159948	**35.03496***	1.1E-06	4.130015
Within Groups	0.155223	34	0.004565			
Total	0.315171	35				

TABLE 23: ANOVA Summary for 1994 Average User Cost of Capital Control Ratio: Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.062523	2	0.031262	2.503185	0.092452	3.190721
Within Groups	0.599462	48	0.012489			
Total	0.661985	50				

TABLE 24: ANOVA Summary for 1994 Total Production Cost Control Ratio: Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.781024	2	0.390512	**5.375595***	0.007823	3.190721
Within Groups	3.486978	48	0.072645			
Total	4.268002	50				

TABLE 25: ANOVA Summary for 1994 Average Total Production Cost Control RatiGroups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.254762	1	0.254762	2.807803	0.102473	4.113161
Within Groups	3.266405	36	0.090733			
Total	3.521167	37				

TABLE 26: ANOVA Summary for Average 1994 Total Production Cost Control Ratio: Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.779139	1	0.779139	**6.307981***	0.018565	4.2252
Within Groups	3.211424	26	0.123516			
Total	3.990563	27				

TABLE 27: ANOVA Summary for 1994 Average Total Production Cost Control Ratio: Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.231539	1	0.231539	**15.86759***	0.00034	4.130015
Within Groups	0.496126	34	0.014592			
Total	0.727665	35				

APPENDIX I

ANOVA Summary for Average Cost Efficiency
Milk Yield Distribution of Data

TABLE 1: ANOVA Summary for 1996 Average Feed Cost Control Ratio: Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.002756	2	0.001378	0.329403	0.72069	3.155932
Within Groups	0.242647	58	0.004184			
Total	0.245403	60				

TABLE 2: ANOVA Summary for 1996 Average Total Labour Cost Control Ratio: Groups M1, M2, M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.025992	2	0.012996	**6.578956***	0.00266	3.155932
Within Groups	0.114571	58	0.001975			
Total	0.140563	60				

TABLE 3: ANOVA Summary for 1996 Average Total Labour Cost Control Ratio: Groups M1 and M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.016223	1	0.016223	**7.094536***	0.011181	4.091277
Within Groups	0.089183	39	0.002287			
Total	0.105406	40				

TABLE 4: ANOVA Summary for 1996 Average Total Labour Cost Control Ratio: Groups M1 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.022789	1	0.022789	**11.47333***	0.001687	4.105459
Within Groups	0.073491	37	0.001986			
Total	0.096279	38				

TABLE 5: ANOVA Summary for 1996 Average Total Labour Cost Control Ratio: Groups M2 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.000752	1	0.00752	0.452363	0.505082	4.08474
Within Groups	0.066468	40	0.001662			
Total	0.06722	41				

TABLE 6: ANOVA Summary for 1996 Average User Cost of Capital Control Ratio: Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.0094	2	0.0047	1.214763	0.304218	3.155932
Within Groups	0.224413	58	0.003869			
Total	0.233813	60				

TABLE 7: ANOVA Summary for 1996 Average Total Production Cost Control Ratio: Groups M1, M2, M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.062006	2	0.031003	2.389115	0.100681	3.155932
Within Groups	0.752649	58	0.012977			
Total	0.814655	60				

TABLE 8: ANOVA Summary for 1995 Average Feed Cost Control Ratio: Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.004046	2	0.002023	0.545609	0.58216	3.140443
Within Groups	0.23728	64	0.003707			
Total	0.241325	66				

TABLE 9: ANOVA Summary for 1995 Average Total Labour Cost Control Ratio: Groups M1, M2, M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.045217	2	0.022608	1.919094	0.15509	3.140443
Within Groups	0.753969	64	0.011781			
Total	0.799185	66				

TABLE 10: ANOVA Summary for 1995 Average User Cost of Capital Control Ratio: Groups M1, M2, M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.02827	2	0.014135	**3.631767***	0.032063	3.140443
Within Groups	0.249091	64	0.003892			
Total	0.277361	66				

TABLE 11: ANOVA Summary for 1995 Average User Cost of Capital Control Ratio: Groups M1 and M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.028191	1	0.028191	**8.606132***	0.005046	4.03432
Within Groups	0.163784	50	0.003276			
Total	0.191975	51				

TABLE 12: ANOVA Summary for 1995 Average User Cost of Capital Control Ratio: Groups M1 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.004691	1	0.004691	0.966535	0.331931	4.105459
Within Groups	0.17958	37	0.004854			
Total	0.184271	38				

TABLE 13: ANOVA Summary for 1995 Average User Cost of Capital Control Ratio: Groups M2 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.005703	1	0.005703	1.510185	0.226118	4.078544
Within Groups	0.154819	41	0.003776			
Total	0.160521	42				

TABLE 14: ANOVA Summary for 1995 Average Total Production Cost Control Ratio: Groups M1, M2, M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.14151	2	0.070755	1.905254	0.157129	3.140443
Within Groups	2.376753	64	0.037137			
Total	2.51826					

TABLE 15: ANOVA Summary for 1994 Average Feed Cost Control Ratio: Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.007468	2	0.003734	0.724917	0.487915	3.125763
Within Groups	0.365724	71	0.005151			
Total	0.373192	73				

TABLE 16: ANOVA Summary for 1994 Average Total Labour Cost Control Ratio: Groups M1, M2, M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.041932	2	0.020966	1.715972	0.18716	3.125763
Within Groups	0.867498	71	0.012218			
Total	0.90943	73				

TABLE 17: ANOVA Summary for 1994 Average User Cost of Capital Control Ratio: Groups M1, M2, M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.02948	2	0.01474	1.382496	0.257624	3.125763
Within Groups	0.756988	71	0.010662			
Total	0.786467	73				

TABLE 18: ANOVA Summary for 1994 Average Total Production Cost Control Ratio: Groups M1, M2, M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.175628	2	0.087814	1.422766	0.247834	3.125763
Within Groups	4.382161	71	0.061721			
Total	4.557789	73				

APPENDIX J

ANOVA Summary for Average Economic Profit
Herd Size Distribution of Data

TABLE 1: ANOVA Summary for 1996 Average Economic Profit ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	223.7987	2	111.8994	2.769098	0.073667	3.20928
Within Groups	1778.042	44	40.41005			
Total	2001.841	46				

TABLE 2: ANOVA Summary for 1995 Average Economic Profit ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1166.353	2	583.1764	**7.16883***	0.001983	3.20432
Within Groups	3660.7	45	81.34889			
Total	4827.053	47				

TABLE 3: ANOVA Summary for 1995 Average Economic Profit ($/hl): Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	5.03213	1	5.03213	0.057765	0.811597	4.149086
Within Groups	2787.628	32	87.11336			
Total	2792.66	33				

TABLE 4: ANOVA Summary for 1995 Average Economic Profit ($/hl): Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	890.8998	1	890.8998	**9.89647***	0.004119	4.2252
Within Groups	2340.571	26	90.02198			
Total	3231.471	27				

TABLE 5: ANOVA Summary for 1995 Average Economic Profit ($/hl): Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	907.9013	1	907.9013	**13.24678***	0.000952	4.149086
Within Groups	2193.201	32	68.53753			
Total	3101.102	33				

TABLE 6: ANOVA Summary for 1994 Average Economic Profit ($/hl): Groups H1, H2, and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1589.431	2	794.7156	**8.858812***	0.000531	3.190721
Within Groups	4306.034	48	89.70905			
Total	5895.466	50				

TABLE 7: ANOVA Summary for 1994 Average Economic Profit ($/hl): Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	304.2124	1	304.2124	3.039272	0.089808	4.113161
Within Groups	3603.378	36	100.0938			
Total	3907.59	37				

TABLE 8: ANOVA Summary for 1994 Average Economic Profit ($/hl): Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1571.665	1	1571.665	**11.75587***	0.002032	4.2252
Within Groups	3475.989	26	133.6919			
Total	5047.654	27				

TABLE 9: ANOVA Summary for 1994 Average Economic Profit ($/hl): Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	708.1753	1	708.1753	**15.70949***	0.000359	4.130015
Within Groups	1532.702	34	45.07947			
Total	2249.877	35				

TABLE 10: ANOVA Summary for Change in Average Economic Profit of Group H1 ($/hl): 1994 - 1995

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	75.34904	1	75.34904	0.479723	0.494462	4.210008
Within Groups	4240.831	27	157.0678			
Total	4316.18	28				

TABLE 11: ANOVA Summary for Change in Average Economic Profit of Group H1 ($/hl): 1995 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	61.25752	1	61.25752	0.693955	0.41339	4.279343
Within Groups	2030.281	23	88.27308			
Total	2091.538	24				

TABLE 12: ANOVA Summary for Change in Average Economic Profit of Group H1 ($/hl): 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	258.2521	1	258.2521	1.857865	0.1855	4.259675
Within Groups	3336.114	24	139.0048			
Total	3594.366	25				

TABLE 13: ANOVA Summary for Change in Average Economic Profit of Group H2 ($/hl): 1994 - 1995

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	33.93784	1	33.93784	0.647134	0.425779	4.078544
Within Groups	2150.174	41	52.44327			
Total	2184.112	42				

TABLE 14: ANOVA Summary for Change in Average Economic Profit of Group H2 ($/hl): 1995 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	160.5285	1	160.5285	2.984034	0.091805	4.08474
Within Groups	2151.832	40	53.79581			
Total	2312.361	41				

TABLE 15: ANOVA Summary for Change in Average Economic Profit of Group H2 ($/hl): 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	51.1753	1	51.1753	1.32423	0.256194	4.067047
Within Groups	1661.749	43	38.64533			
Total	1712.924	44				

TABLE 16: ANOVA Summary for Change in Average Economic Profit of Group H3 ($/hl): 1994 - 1995

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.789802	1	1.789802	0.028396	0.867536	4.241699
Within Groups	1575.729	25	63.02916			
Total	1577.519	26				

TABLE 17: ANOVA Summary for Change in Average Economic Profit of Group H3 ($/hl): 1995 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	44.37622	1	44.37622	0.918156	0.346786	4.2252
Within Groups	1256.629	26	48.33189			
Total	1301.005	27				

TABLE 18: ANOVA Summary for Change in Average Economic Profit of Group H3 ($/hl): 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	62.01337	1	62.01337	1.427283	0.24342	4.241699
Within Groups	1086.213	25	43.44854			
Total	1148.227	26				

APPENDIX K

ANOVA Summary for Comparison of Top and Bottom 5 Percent of Profitable Farms

Herd Size Distribution of Data

TABLE 1: ANOVA Summary for Average Years Farming of Group H1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	308.1667	1	308.1667	1.983906	0.231757	7.70865
Within Groups	621.3333	4	155.3333			
Total	929.5	5				

TABLE 2: ANOVA Summary for Average Milk Yield per Cow (hl/cow) of Group H1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	204.0034	1	204.0034	2.043139	0.226107	7.70865
Within Groups	399.3921	4	99.84802			
Total	603.3955	5				

TABLE 3: ANOVA Summary for Average Quota Holding (hl) of Group H1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	95069.61	1	95069.61	0.192579	0.683422	7.70865
Within Groups	1974666.18	4	493666.5			
Total	2069735.79	5				

TABLE 4: ANOVA Summary for Average Percent Over Quota Milk Production of Group H1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	69.84830197	1	69.8483	0.113869	0.752746	7.70865
Within Groups	2453.628371	4	613.4071			
Total	2523.476673	5				

TABLE 5: ANOVA Summary for Average Quota Holding ($) of Group H1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	172311343.5	1	1.72E+08	0.106262	0.760782	7.70865
Within Groups	6486291353	4	1.62E+09			
Total	6658602697	5				

TABLE 6: ANOVA Summary for Average Net Cattle Sales of Group H1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	208.597498	1	208.5975	1.362526	0.307938	7.70865
Within Groups	612.3844199	4	153.0961			
Total	820.9819179	5				

TABLE 7: ANOVA Summary for Average Total Feed Cost ($/hl) of Group H1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	22.69163755	1	22.69164	2.501314	0.188911	7.70865
Within Groups	36.28754049	4	9.071885			
Total	58.97917805	5				

TABLE 8: ANOVA Summary for Average Breeding Cost ($/hl) of Group H1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.083482035	1	0.083482	0.598031	0.482491	7.709865
Within Groups	0.558379494	4	0.139595			
Total	0.641861529	5				

TABLE 9: ANOVA Summary for Average Veterinary and Medicine Cost ($/hl) of Group H1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.641538809	1	0.641539	3.025692	0.156939	7.70865
Within Groups	0.848121706	4	0.21203			
Total	1.489660515	5				

TABLE 10: ANOVA Summary for Average Repairs Cost ($/hl) of Group H1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2.243780599	1	2.243781	1.329903	0.313043	7.70865
Within Groups	6.748702484	4	1.687176			
Total	8.992483083	5				

TABLE 11: ANOVA Summary for Average Miscellaneous Costs ($/hl) of Group H1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.363040251	1	0.36304	0.265779	0.633362	7.70865
Within Groups	5.463798444	4	1.36595			
Total	5.826838695	5				

TABLE 12: ANOVA Summary for Average Hired Labour Cost ($/hl) of Group H1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.965576216	1	1.965576	0.349207	0.586338	7.70865
Within Groups	22.51471608	4	5.628679			
Total	24.4802923	5				

TABLE 13: ANOVA Summary for Average Family Labour Cost ($/hl) of Group H1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	19.37414098	1	19.37414	1.791407	0.251767	7.70865
Within Groups	43.26015908	4	10.81504			
Total	62.63430005	5				

TABLE 14: ANOVA Summary for Average Operator Labour Cost ($/hl) of Group H1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	14.99162708	1	14.99163	0.393004	0.564727	7.70865
Within Groups	152.5848359	4	38.14621			
Total	167.576463	5				

TABLE 15: ANOVA Summary for Average Rent Cost ($/hl) of Group H1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2.023363299	1	2.023363	0.695804	0.451115	7.70865
Within Groups	11.63179677	4	2.907949			
Total	13.65516007	5				

TABLE 16: ANOVA Summary for Average User Cost of Buildings ($/hl) of Group H1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	40.25864302	1	40.25864	4.222509	0.109085	7.70865
Within Groups	38.13717861	4	9.534295			
Total	78.39582164	5				

TABLE 17: ANOVA Summary for Average User Cost of Machinery and Equipment ($/hl) of Group H1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	7.716044015	1	7.716044	12.02909*	0.025623	7.70865
Within Groups	2.565794085	4	0.641449			
Total	10.2818381	5				

TABLE 18: ANOVA Summary for Average User Cost of Land ($/hl) of Group H1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.879091177	1	1.879091	0.732484	0.440319	7.70865
Within Groups	10.26147604	4	2.5655369			
Total	12.14056721	5				

TABLE 19: ANOVA Summary for Average User Cost of Dairy Herd ($/hl) of Group H1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.009491047	1	0.009491	0.152513	0.716051	7.70865
Within Groups	0.248924001	4	0.062231			
Total	0.258415048	5				

TABLE 20: ANOVA Summary for Average Years Farming of Group H2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	42.00833	1	42.00833	0.413287	0.544075	5.987374
Within Groups	609.8667	6	101.6444			
Total	651.875	7				

TABLE 21: ANOVA Summary for Average Milk Yield per Cow (hl/cow) of Group H2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	379.1535	1	379.1535	1.922645	0.214888	5.987374
Within Groups	1183.225	6	197.2041			
Total	1562.378	7				

TABLE 22: ANOVA Summary for Average Quota Holding (hl) of Group H2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	519696.3054	1	519696.3	0.579534	0.475341	5.987374
Within Groups	5380493.286	6	896748.9			
Total	5900189.591	7				

TABLE 23: ANOVA Summary for Average Percent Over Quota Milk Production of Group H2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	84.74191413	1	84.74191	0.350826	0.575271	5.987374
Within Groups	1449.29726	6	241.5495			
Total	1534.039174	7				

TABLE 24: ANOVA Summary for Average Quota Holding ($) of Group H2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1142421617	1	1.14E+09	0.458683	0.5238	5.98737
Within Groups	14943935422	6	2.49E+09			
Total	16086357040	7				

TABLE 25: ANOVA Summary for Average Net Cattle Sales of Group H2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	39.9007	1	39.900077	0.547615	0.487228	5.987374
Within Groups	437.1768	6	72.8628			
Total	477.0776	7				

TABLE 26: ANOVA Summary for Average Total Feed Cost ($/hl) of Group H2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	77.35059	1	77.35059	3.857439	0.09715	5.987374
Within Groups	120.3139	6	20.05231			
Total	197.6645	7				

TABLE 27: ANOVA Summary for Average Breeding Cost ($/hl) of Group H2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	3.616241	1	3.616241	1.957514	0.211294	5.987374
Within Groups	11.08418	6	1.847364			
Total	14.70043	7				

TABLE 28: ANOVA Summary for Average Veterinary and Medicine Cost ($/hl) of Group H2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.352799	1	0.352799	0.37803	0.561237	5.987374
Within Groups	5.599545	6	0.933257			
Total	5.952344	7				

TABLE 29: ANOVA Summary for Average Repairs Cost ($/hl) of Group H2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.655304	1	1.655304	0.963648	0.36418	5.987374
Within Groups	10.30648	6	1.717747			
Total	11.96179	7				

TABLE 30: ANOVA Summary for Average Miscellaneous Costs ($/hl) of Group H2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.799356	1	0.799356	1.211037	0.313306	5.987374
Within Groups	3.960352	6	0.660059			
Total	4.759708	7				

TABLE 31: ANOVA Summary for Average Hired Labour Cost ($/hl) of Group H2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	4.816593	1	4.816593	0.959544	0.365132	5.987374
Within Groups	30.11799	6	5.019666			
Total	34.93459	7				

TABLE 32: ANOVA Summary for Average Family Labour Cost ($/hl) of Group H2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	16.31604	1	16.31604	2.945731	0.13692	5.987374
Within Groups	33.23327	6	5.538878			
Total	49.54931	7				

TABLE 33: ANOVA Summary for Average Operator Labour Cost ($/hl) of Group H2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	18.03107	1	18.03107	4.003864	0.092303	5.987374
Within Groups	27.0205	6	4.503417			
Total	45.05157	7				

TABLE 34: ANOVA Summary for Average Rent Cost ($/hl) of Group H2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.58491	1	0.58491	0.298324	0.604634	5.987374
Within Groups	11.76393	6	1.960654			
Total	12.34884	7				

TABLE 35: ANOVA Summary for Average User Cost of Buildings ($/hl) of Group H2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.000385	1	0.000385	0.000168	0.990081	5.987374
Within Groups	13.76531	6	2.294218			
Total	13.76569	7				

TABLE 36: ANOVA Summary for Average User Cost of Machinery and Equipment ($/hl) of Group H2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	6.99E-05	1	6.99E-05	6.62E-05	0.99377	5.987374
Within Groups	6.329512	6	1.054919			
Total	6.329582	7				

TABLE 37: ANOVA Summary for Average User Cost of Land ($/hl) of Group H2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.060496	1	1.060496	1.478614	0.269657	5.987374
Within Groups	4.303339	6	0.717223			
Total	5.363835	7				

TABLE 38: ANOVA Summary for Average User Cost of Dairy Herd ($/hl) of Group H2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.069791	1	0.069791	0.583138	0.474032	5.987374
Within Groups	0.718088	6	0.119681			
Total	0.787879	7				

TABLE 39: ANOVA Summary for Average Years Farming of Group H3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	228.1667	1	228.1667	2.587902	0.182966	7.70865
Within Groups	352.6667	4	88.16667			
Total	580.8333	5				

TABLE 40: ANOVA Summary for Average Milk Production per Cow (hl/cow) of Group H3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	328.8185	1	328.8185	21.85725*	0.009482	7.70865
Within Groups	60.17564	4	15.04391			
Total	388.9941	5				

TABLE 41: ANOVA Summary for Average Quota Holding (hl) of Group H3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	56775639.23	1	56775639.23	30.85574*	0.005141	7.70865
Within Groups	7360139.588	4	1840034.897			
Total	64135778.82	5				

TABLE 42: ANOVA Summary for Average Percent Over Quota Milk Production of Group H3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1671.515341	1	1671.515341	5.528296	0.07841	7.70865
Within Groups	1209.425305	4	302.3563263			
Total	2880.940646	5				

TABLE 43: ANOVA Summary for Average Quota Holding ($) of Group H3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.42022E+11	1	1.42022E+11	14.90713*	0.018132	7.70865
Within Groups	38108581519	4	9527145380			
Total	1.80131E+11	5				

TABLE 44: ANOVA Summary for Average Net Cattle Sales of Group H3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	3.52225	1	3.52225	0.673219	0.458012	7.70865
Within Groups	20.92782	4	5.231954			
Total	24.45007	5				

TABLE 45: ANOVA Summary for Average Total Feed Cost ($/hl) of Group H3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	49.62750456	1	49.62750456	7.428772	0.052683	7.70865
Within Groups	26.72178217	4	6.680445543			
Total	76.34928673	5				

TABLE 46: ANOVA Summary for Average Breeding Cost ($/hl) of Group H3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.813301482	1	0.813301482	1.23302	0.23302	7.70865
Within Groups	2.638404283	4	0.659601071			
Total	3.451705765	5				

TABLE 47: ANOVA Summary for Average Veterinary and Medicine Cost ($/hl) of Group H3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	3.433611177	1	3.43361117	2.347927	0.200215	7.70865
Within Groups	5.849605117	4	1.462401279			
Total	9.283216293	5				

TABLE 48: ANOVA Summary for Average Repairs Cost ($/hl) of Group H3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.362425664	1	0.362425664	0.593094	0.484186	7.70865
Within Groups	2.444305618	4	0.611076404			
Total	2.806731283	5				

TABLE 49: ANOVA Summary for Average Miscellaneous Costs ($/hl) of Group H3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.736933686	1	0.736933686	0.574198	0.490785	7.70865
Within Groups	5.133657853	4	1.283414463			
Total	5.870591539	5				

TABLE 50: ANOVA Summary for Average Hired Labour Cost ($/hl) of Group H3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2.440067348	1	2.300673489	0.34346	0.589313	7.70865
Within Groups	27.95869148	4	6.98967287			
Total	30.35936497	5				

TABLE 51: ANOVA Summary for Average Family Labour Cost ($/hl) of Group H3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	9.656818996	1	9.656818996	13.29306*	0.021849	7.70865
Within Groups	2.905822254	4	0.726455563			
Total	12.56264125	5				

TABLE 52: ANOVA Summary for Average Operator Labour Cost ($/hl) of Group H3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	6.75505092	1	6.75505092	12.84086*	0.023097	7.70865
Within Groups	2.10423578	4	0.526058945			
Total	8.8592867	5				

TABLE 53: ANOVA Summary for Average Rent Cost ($/hl) of Group H3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.747533	1	0.747533	1.502587	0.287507	7.70865
Within Groups	1.98999	4	0.497498			
Total	2.737523	5				

TABLE 54: ANOVA Summary for Average User Cost of Buildings ($/hl) of Group H3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	4.729791	1	4.729791	1.033021	0.366928	7.70865
Within Groups	18.3144	4	4.5786			
Total	23.04419	5				

TABLE 55: ANOVA Summary for Average User Cost of Machinery and Equipment ($/hl) of Group H3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.383659	1	1.383659	1.94011	0.23608	7.70865
Within Groups	2.852744	4	0.713186			
Total	4.236403	5				

TABLE 56: ANOVA Summary for Average User Cost of Land ($/hl) of Group H3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.019073	1	0.019073	0.505831	0.516225	7.70865
Within Groups	0.150829	4	0.037707			
Total	0.169902	5				

TABLE 57: ANOVA Summary for Average User Cost of Dairy Herd ($/hl) of Group H3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.039785	1	0.039785	1.72773	0.259003	7.70865
Within Groups	0.09211	4	0.023028			
Total	0.131895	5				

APPENDIX L

ANOVA Summary for Average Economic Profit
Milk Yield Distribution of Data

TABLE 1: ANOVA Summary for 1996 Average Economic Profit ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	203.4294	2	101.7147	2.347018	0.104677	3.155932
Within Groups	2513.594	58	43.33784			
Total	2717.024	60				

TABLE 2: ANOVA Summary for 1995 Average Economic Profit ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	429.3902	2	214.6951	2.419974	0.09702	3.140443
Within Groups	5677.948	64	88.71794			
Total	6107.338	66				

TABLE 3: ANOVA Summary for 1994 Average Economic Profit ($/hl): Groups M1, M2, and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	283.8423	2	141.9211	1.551192	0.219093	3.125763
Within Groups	6495.908	71	91.49166			
Total	6779.75	73				

TABLE 4: ANOVA Summary for Change in Average Economic Profit of Group M1 ($/hl): 1994 - 1995

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	13.45847	1	13.45847	0.109342	0.742151	4.016186
Within Groups	6769.718	55	123.0858			
Total	6783.176	56				

TABLE 5: ANOVA Summary for Change in Average Economic Profit of Group M1 ($/hl): 1995 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	136.0864	1	136.0864	1.611415	0.211452	4.078544
Within Groups	3462.513	41	84.45154			
Total	3598.599	42				

TABLE 6: ANOVA Summary for Change in Average Economic Profit of Group M1 ($/hl): 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	81.39101	1	81.39101	0.801197	0.375025	4.03432
Within Groups	5079.341	50	101.5868			
Total	5160.732	51				

TABLE 7: ANOVA Summary for Change in Average Economic Profit of Group M2 ($/hl): 1994 - 1995

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.032912	1	0.032912	0.000531	0.981722	4.051742
Within Groups	2853.103	46	62.02398			
Total	2853.136	47				

TABLE 8: ANOVA Summary for Change in Average Economic Profit of Group M2 ($/hl): 1995 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	40.88586	1	40.885886	0.641525	0.427106	4.042647
Within Groups	3059.15	48	63.7323			
Total	3100.036	49				

TABLE 9: ANOVA Summary for Change in Average Economic Profit of Group M2 ($/hl): 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	36.82375	1	36.82375	0.97675	0.328943	4.08474
Within Groups	1508.011	40	37.70027			
Total	1544.835	41				

TABLE 10: ANOVA Summary for Change in Average Economic Profit of Group M3 ($/hl): 1994 - 1995

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	3.726857	1	3.726857	0.049671	0.82497	4.130015
Within Groups	2551.035	34	75.03045			
Total	2554.762	35				

TABLE 11: ANOVA Summary for Change in Average Economic Profit of Group M3 ($/hl): 1995 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	63.35286	1	63.35286	1.251973	0.271255	4.139252
Within Groups	1669.879	33	50.6024			
Total	1733.232	34				

TABLE 12: ANOVA Summary for Change in Average Economic Profit of Group M3 ($/hl): 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	116.4288	1	116.4288	1.874666	0.178776	4.091277
Within Groups	2422.15	39	62.10642			
Total	2538.579	40				

APPENDIX M

ANOVA Summary for Comparison of Top and Bottom 5 Percent of Profitable Farms

Milk Yield Distribution of Data

TABLE 1: ANOVA Summary for Years Farming of Group M1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	40.13889	1	40.13889	0.308506	0.595894	5.59146
Within Groups	910.75	7	130.1071			
Total	950.8889	8				

TABLE 2: ANOVA Summary for Herd Size of Group M: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	14768.1	1	14768.1	8.757045*	0.021128	5.59146
Within Groups	11804.98	7	1686.425			
Total	26573.08	8				

TABLE 3: ANOVA Summary for Quota Holding (hL) of Group M1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	66773781.51	1	66773781.51	10.64763*	0.013806	5.59146
Within Groups	43898638.86	7	6271234.122			
Total	110672420.4	8				

TABLE 4: ANOVA Summary for Percent over Quota Production of Group M1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	23.04535608	1	23.04535608	0.193069	0.673619	5.59146
Within Groups	835.5413152	7	119.363045			
Total	858.5866713	8				

TABLE 5: ANOVA Summary for Quota Holding ($) of Group M1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2.00258E+11	1	2.00258E+11	11.09694*	0.01257	5.59146
Within Groups	1.26324E+11	7	18046221372			
Total	3.26581E+11	8				

TABLE 6: ANOVA Summary for Net Cattle Sales of Group M1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	156.9147015	1	156.9147015	1.31969	0.288383	5.59146
Within Groups	832.3190495	7	118.9027214			
Total	989.233751	8				

TABLE 7: ANOVA Summary for Total Feed Cost of Group M1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	42.73992707	1	42.73992707	5.215242	0.056329	5.59146
Within Groups	57.36636555	7	8.195195079			
Total	100.1062926	8				

TABLE 8: ANOVA Summary for Breeding Cost of Group M1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.052427284	1	0.052427284	0.292478	0.605411	5.59146
Within Groups	1.254766129	7	0.179252304			
Total	1.307193413	8				

TABLE 9: ANOVA Summary for Veterinary and Medicine Cos of Group M1 t: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.301607625	1	0.301607625	1.753698	0.227013	5.59146
Within Groups	1.203886456	7	0.171983779			
Total	1.50549081	8				

TABLE 10: ANOVA Summary for Repairs Cost of Group M1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.122307983	1	0.122307983	0.071311	0.797134	5.59146
Within Groups	12.00599442	7	1.71514206			
Total	12.1283024	8				

TABLE 11: ANOVA Summary for Miscellaneous Costs of Group M1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.025582684	1	0.025582684	0.0557	0.820182	5.59146
Within Groups	3.215045231	7	0.459292176			
Total	3.240627916	8				

TABLE 12: ANOVA Summary for Hired Labour Cost of Group M1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	14.99128738	1	14.99128738	3.356843	0.109596	5.59146
Within Groups	31.26122443	7	4.465889204			
Total	46.2525118	8				

TABLE 13: ANOVA Summary for Family Labour Cost of Group M1: 1994 -1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	58.77419983	1	58.77419983	10.6243*	0.013874	5.59146
Within Groups	38.72436252	7	5.532051789			
Total	97.49856235	8				

TABLE 14: ANOVA Summary for Operator Labour Cost of Group M1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	68.43103172	1	68.43103172	2.026701	0.197565	5.59146
Within Groups	236.3531965	7	33.76474235			
Total	304.7842282	8				

TABLE 15: ANOVA Summary for Rent Cost of Group M1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.647604157	1	1.647604157	0.796162	0.401874	5.59146
Within Groups	14.48602579	7	2.069432255			
Total	16.13362995	8				

TABLE 16: ANOVA Summary for User Cost of Buildings of Group M1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	61.79398976	1	61.79398976	10.20271*	00.015188	5.59146
Within Groups	42.39639236	7	6.056627479			
Total	104.1903821	8				

TABLE 17: ANOVA Summary for User Cost of Machinery and Equipment of Group M1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	23.85658209	1	23.85658209	10.83607*	0.013269	5.59146
Within Groups	15.4111302	7	2.201590028			
Total	39.26771229	8				

TABLE 18: ANOVA Summary for User Cost of Land of Group M1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2.819803399	1	2.819803399	1.757346	0.22658	5.59146
Within Groups	11.23206422	7	1.604580603			
Total	14.05186762	8				

TABLE 19: ANOVA Summary for User Cost of Cattle of Group M1: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.014592571	1	0.014592571	0.225891	0.64906	5.59146
Within Groups	0.452200512	7	0.064600073			
Total	0.466793083	8				

TABLE 20: ANOVA Summary for Years Farming of Group M2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	12.8	1	12.8	0.069825	0.799202	5.59146
Within Groups	1283.2	7	183.3142857			
Total	1296	8				

TABLE 21: ANOVA Summary for Herd Size of Group M2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	10861.68368	1	10861.68368	**30.78093***	0.000862	5.59146
Within Groups	2470.094097	7	352.8705853			
Total	13331.77778	8				

TABLE 22: ANOVA Summary for Quota Holding (hL) of Group M2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	66572027.65	1	66572027.65	**28.61491***	0.001065	5.59146
Within Groups	16285362.02	7	2326480.288			
Total	82857389.67	8				

TABLE 23: ANOVA Summary for Percent Over Quota Production of Group M2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	113.6022	1	113.6022	0.465575	0.516965	5.59146
Within Groups	1708.028	7	244.0041			
Total	1821.631	8				

TABLE 24: ANOVA Summary for Quota Holding ($) of Group M2: 1994- 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.98E+11	1	1.98E+11	**28.33328***	0.001096	5.59146
Within Groups	4.88E+10	7	6.97E+09			
Total	2.46E+11	8				

TABLE 25: ANOVA Summary for Net Cattle Sales of Group M2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	117.488	1	117.488	1.860303	0.214823	5.59146
Within Groups	442.0871	7	63.15529			
Total	559.575	8				

TABLE 26: ANOVA Summary for Total Feed Cost of Group M2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	16.04774	1	16.04774	2.695633	0.144627	5.59146
Within Groups	41.67265	7	5.953236			
Total	57.7204	8				

TABLE 27: ANOVA Summary for Breeding Cost of Group M2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.429203	1	1.429203	1.792352	0.222483	5.59146
Within Groups	5.581731	7	0.79739			
Total	7.010934	8				

TABLE 28: ANOVA Summary for Veterinary & Medicine Cost of Group M2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.093872	1	1.093872	1.189183	0.311603	5.59146
Within Groups	6.438957	7	0.919851			
Total	7.532829	8				

TABLE 29: ANOVA Summary for Repairs Cost of Group M2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2.33E-06	1	2.33E-06	4.34E-06	0.998397	5.59146
Within Groups	3.764669	7	0.53781			
Total	3.764671	8				

TABLE 30: ANOVA Summary for Miscellaneous Costs of Group M2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.34816	1	1.34816	1.625951	0.242952	5.59146
Within Groups	5.804061	7	0.829152			
Total	7.152221	8				

TABLE 31: ANOVA Summary for Hired Labour Cost of Group M2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.262071	1	1.262071	0.133675	0.725451	5.59146
Within Groups	66.08962	7	9.441374			
Total	67.35169	8				

TABLE 32: ANOVA Summary for Family Labour Cost of Group M2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	30.02981	1	30.02981	**46.42983***	0.00025	5.59246
Within Groups	4.527449	7	0.646778			
Total	34.55726	8				

TABLE 33: ANOVA Summary for Operator Labour Cost of Group M2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	57.91867	1	57.91867	**84.74173***	3.68E-05	5.59146
Within Groups	4.78431	7	0.683473			
Total	62.70298	8				

TABLE 34: ANOVA Summary for Rent Cost of Group M2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.002151	1	0.002151	0.005509	0.942908	5.59146
Within Groups	2.733127	7	0.390447			
Total	2.735278	8				

TABLE 35: ANOVA Summary for User Cost of Buildings of Group M2: 1994-1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2.486241	1	2.486241	0.323936	0.587041	5.59146
Within Groups	53.72567	7	7.675096			
Total	56.21192	8				

TABLE 36: ANOVA Summary for User Cost of Machinery and Equipment of Group M2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	4.379929	1	4.379929	16.03747*	0.005159	5.59146
Within Groups	1.911742	7	0.273106			
Total	6.29167	8				

TABLE 37: ANOVA Summary for User Cost of Group M2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.969736	1	0.969736	2.935163	0.130395	5.59146
Within Groups	2.312701	7	0.330386			
Total	3.282438	8				

TABLE 38: ANOVA Summary for User Cost of Cattle of Group M2: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.064443	1	0.064443	1.566179	0.250962	5.59146
Within Groups	0.288027	7	0.041147			
Total	0.352471	8				

TABLE 39: ANOVA Summary for Years Farming of Group M3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	78.125	1	78.125	0.383357	0.558573	5.987374
Within Groups	1222.75	6	203.7917			
Total	1300.875	7				

TABLE 40: ANOVA Summary for Herd Size of Group M3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	5278.781	1	5278.781	4.114126	0.088869	5.987374
Within Groups	7698.521	6	1283.087			
Total	12977.3	7				

TABLE 41: ANOVA Summary for Quota Holding (hL) of Group M3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	49323752.15	1	49323752.15	5.445088	0.058363	5.987374
Within Groups	54350361.98	6	9058393.644			
Total	103674114.1	7				

TABLE 42: ANOVA Summary for Percentage Over Quota Production of Group M3: 1994- 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	560.0551	1	560.0551	2.144121	0.193456	5.987374
Within Groups	1567.23	6	261.2049			
Total	2127.285	7				

TABLE 43: ANOVA Summary for Quota Holding ($) of Group M3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1.41E+11	1	1.41E+11	5.380814	0.059477	5.987374
Within Groups	1.57E+11	6	2.62E+10			
Total	2.98E+11	7				

TABLE 44: ANOVA Summary for Net Cattle Sales of Group M3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	43.28138	1	43.28138	4.328969	0.082664	5.987374
Within Groups	59.98848	6	9.99808			
Total	103.2699	7				

TABLE 45: ANOVA Summary for Total Feed Cost of Group M3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	30.32779	1	30.32779	2.994884	0.134248	5.987374
Within Groups	60.75919	6	10.12653			
Total	91.08698	7				

TABLE 46: ANOVA Summary for Breeding Cost of Group M3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.281571	1	0.281571	11.70401*	0.014124	5.987374
Within Groups	0.144346	6	0.024058			
Total	0.425917	7				

TABLE 47: ANOVA Summary for Veterinary & Medicine Cost of Group M3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.479847	1	0.479847	3.004218	0.133749	5.987374
Within Groups	0.958346	6	0.159724			
Total	1.438193	7				

TABLE 48: ANOVA Summary for Repairs Cost of Group M3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.005445	1	0.005445	0.006711	0.937375	5.987374
Within Groups	4.868495	6	0.811416			
Total	4.87394	7				

TABLE 49: ANOVA Summary for Miscellaneous Costs of Group M3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.005648	1	0.005648	0.012664	0.914071	5.987374
Within Groups	2.67574	6	0.445957			
Total	2.681387	7				

TABLE 50: ANOVA Summary for Hired Labour Cost of Group M3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	8.099851	1	8.099851	3.42989	0.113476	5.987374
Within Groups	14.16929	6	2.361549			
Total	22.26914	7				

TABLE 51: ANOVA Summary for Family Labour Cost of Group M3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	11.48997	1	11.48997	18.69508*	0.004962	5.987374
Within Groups	3.687592	6	0.614599			
Total	15.17756	7				

TABLE 52: ANOVA Summary for Operator Labour Cost of Group M3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	13.31756	1	13.31756	1.699644	0.240118	5.987374
Within Groups	47.01301	6	7.835501			
Total	60.33057	7				

TABLE 53: ANOVA Summary for Rent Cost of Group M3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.436991	1	0.436991	0.755091	0.418268	5.987374
Within Groups	3.472356	6	0.578726			
Total	3.909346	7				

TABLE 54: ANOVA Summary for User Cost of Buildings of Group M3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	66.9364	1	66.9364	3.52102	0.109695	5.987374
Within Groups	114.0631	6	19.01051			
Total	180.9995	7				

TABLE 55: ANOVA Summary for User Cost of Machinery & Equipment of Group M3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.355541	1	0.355541	0.032852	0.862139	5.987374
Within Groups	64.93566	6	10.82261			
Total	65.2912	7				

TABLE 56: ANOVA Summary for User Cost of Land of Group M3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.158509	1	0.158509	2.233252	0.18569	5.987374
Within Groups	0.425862	6	0.070977			
Total	0.584371	7				

TABLE 57: ANOVA Summary for User Cost of Cattle of Group M3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.034823	1	0.034823	0.459913	0.522944	5.987374
Within Groups	0.454302	6	0.075717			
Total	0.489125	7				

APPENDIX N

ANOVA Summary for Economic Profit at Selected International Milk Prices

Herd Size Distribution of Data

TABLE 1: ANOVA Summary for 1996 US Price Simulation

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	296.6054	2	148.3027	3.415083*	0.04181	3.20928
Within Groups	1910.735	44	43.42579			
Total	2207.34	46				

TABLE 2: ANOVA Summary for 1996 US Price Simulation Between Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	93.06188	1	93.06188	1.915652	0.176221	4.159617
Within Groups	1505.972	31	48.57975			
Total	1599.034	32				

TABLE 3: ANOVA Summary for 1996 US Price Simulation Between Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	295.4378	1	295.4378	6.71596*	0.016317	4.279343
Within Groups	1011.78	23	43.99041			
Total	1307.217	24				

TABLE 4: ANOVA Summary for 1996 US Price Simulation Between Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	96.76291	1	96.76291	2.523506	0.121418	4.130015
Within Groups	1303.718	34	38.34463			
Total	1400.48	35				

TABLE 5: ANOVA Summary for 1996 Mexico Price Simulation

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	296.6054	2	148.3027	3.415083*	0.04181	3.20928
Within Groups	1910.735	44	43.42579			
Total	2207.34	46				

TABLE 6: ANOVA Summary for 1996 Mexico Price Simulation Between Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	93.06188	1	93.06188	1.915652	0.176221	4.159617
Within Groups	1505.972	31	48.57975			
Total	1599.034	32				

TABLE 7: ANOVA Summary for 1996 Mexico Price Simulation Between Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	295.4378	1	295.4378	**6.71596***	0.016317	4.279343
Within Groups	1011.78	23	43.99041			
Total	1307.217	24				

TABLE 8: ANOVA Summary for 1996 Mexico Price Simulation Between Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	96.76291	1	96.76291	2.523506	0.121418	4.130015
Within Groups	1303.718	34	38.34463			
Total	1400.48	35				

TABLE 9: ANOVA Summary for 1996 New Zealand Price Simulation

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	296.6054	2	148.3027	**3.415083***	0.04181	3.20928
Within Groups	1910.735	44	43.42579			
Total	2207.34	46				

TABLE 10: ANOVA Summary for 1996 New Zealand Price Simulation Between Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	93.06188	1	93.06188	1.915652	0.176221	4.159617
Within Groups	1505.972	31	48.57975			
Total	1599.034	32				

TABLE 11: ANOVA Summary for 1996 New Zealand Price Simulation Between Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	295.4378	1	295.4378	6.71596*	0.016317	4.279343
Within Groups	1011.78	23	43.99041			
Total	1307.217	24				

TABLE 12: ANOVA Summary for 1996 New Zealand Price Simulation Between Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	96.76291	1	96.76291	2.523506	0.121418	4.130015
Within Groups	1303.718	34	38.34463			
Total	1400.48	35				

TABLE 13: ANOVA Summary for 1996 Free Trade Price Simulation

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	241.9528	2	120.9764	2.907928	0.065144	3.20928
Within Groups	1830.5000	44	41.60227			
Total	2072.4528	46				

TABLE 14: ANOVA Summary for 1995 US Price Simulation

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1051.063	2	525.5314	6.795909*	0.002636	3.20432
Within Groups	3479.875	45	77.33056			
Total	4530.938	47				

TABLE 15: ANOVA Summary for 1995 US Price Simulation Between Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.553445	1	0.553445	0.006571	0.935896	4.149086
Within Groups	2695.093	32	84.22165			
Total	2695.646	33				

TABLE 16: ANOVA Summary for 1995 US Price Simulation Between Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	719.7256	1	719.7256	8.975281*	0.005945	4.2252
Within Groups	2084.934	26	80.18975			
Total	2804.659	27				

TABLE 17: ANOVA Summary for 1995 US Price Simulation Between Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	890.5847	1	890.5847	13.07446*	0.001016	4.149086
Within Groups	2179.724	32	68.11637			
Total	3070.309	33				

TABLE 18: ANOVA Summary for 1995 Mexico Price Simulation

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1051.063	2	525.5314	6.795909*	0.002636	3.20432
Within Groups	3479.875	45	77.33056			
Total	4530.938	47				

TABLE 19: ANOVA Summary for 1995 Mexico Price Simulation Between Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.553445	1	0.553445	0.006571	0.935896	41.149086
Within Groups	2695.093	32	84.22165			
Total	2695.646	33				

TABLE 20: ANOVA Summary for 1995 Mexico Price Simulation Between Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	719.7256	1	719.7256	8.975281*	0.005945	4.2252
Within Groups	2084.934	26	80.18975			
Total	2804.659	27				

TABLE 21: ANOVA Summary for 1995 Mexico Price Simulation Between Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	890.5847	1	890.5847	**13.07446***	0.001016	4.149086
Within Groups	2179.724	32	68.11637			
Total	3070.309	33				

TABLE 22: ANOVA Summary for 1995 New Zealand Price Simulation

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1051.063	2	525.5314	**6.795909***	0.002636	3.20432
Within Groups	3479.875	45	77.33056			
Total	4530.938	47				

TABLE 23: ANOVA Summary for 1995 New Zealand Price Simulation Between Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.553445	1	0.553445	0.006571	0.935896	4.149086
Within Groups	2695.093	32	84.22165			
Total	2695.646	33				

TABLE 24: ANOVA Summary for 1995 New Zealand Price Simulation Between Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	719.7256	1	719.7256	**8.975281***	0.005945	4.2252
Within Groups	2084.934	26	80.18975			
Total	2804.659	27				

TABLE 25: ANOVA Summary for 1995 New Zealand Price Simulation Between Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	890.5847	1	890.5847	**13.07446***	0.001016	4.149086
Within Groups	2179.724	32	68.11637			
Total	3070.309	33				

TABLE 26: ANOVA Summary for 1995 Free Trade Price Simulation

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1063.5941	2	531.7971	6.7442143*	0.002743	3.20432
Within Groups	3548.35575	45	78.85235			
Total	4611.9498	47				

TABLE 27: ANOVA Summary for 1995 Free Trade Price Simulation Between Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.038446	1	0.038446	0.000477	0.982719	4.149086
Within Groups	2581.536	32	80.67299			
Total	2581.574	33				

TABLE 28: ANOVA Summary for 1995 Free Trade Price Simulation Between Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	744.9292	1	744.9292	8.680855*	0.006702	4.2252
Within Groups	2231.064	26	85.81289			
Total	2976.064	27				

TABLE 29: ANOVA Summary for 1995 Free Trade Price Simulation Between Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	888.035	1	888.035	12.4416*	0.001294	4.149086
Within Groups	2284.041	32	71.37627			
Total	3172.076	33				

TABLE 30: ANOVA Summary for 1994 US Price Simulation

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1703.71	2	851.8548	8.891004*	0.000519	3.190721
Within Groups	4598.922	48	95.81087			
Total	6302.631	50				

TABLE 31: ANOVA Summary for 1994 US Price Simulation Between Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	396.3151	1	396.3151	3.600046	0.065821	4.113161
Within Groups	3963.1	36	110.0861			
Total	4359.415	37				

TABLE 32: ANOVA Summary for 1994 US Price Simulation Between Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1698.478	1	1698.478	11.70181*	0.002073	4.2252
Within Groups	37773.813	26	145.1466			
Total	5472.29	27				

TABLE 33: ANOVA Summary for 1994 US Price Simulation Between Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	674.2177	1	674.2177	15.69096*	0.000362	4.130015
Within Groups	1460.93	34	42.96854			
Total	2135.148	35				

TABLE 34: ANOVA Summary for 1994 Mexico Price Simulation

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1703.71	2	851.8548	8.891004*	0.000519	3.190721
Within Groups	4598.922	48	95.81087			
Total	6302.631	50				

TABLE 35: ANOVA Summary for 1994 Mexico Price Simulation Between Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	396.3151	1	396.3151	3.600046	0.065821	4.113161
Within Groups	3963.1	36	110.0861			
Total	4359.415	37				

TABLE 36: ANOVA Summary for 1994 Mexico Price Simulation Between Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1689.478	1	1698.478	11.70181*	0.002073	4.2252
Within Groups	3773.813	26	145.1466			
Total	5472.29	27				

TABLE 37: ANOVA Summary for 1994 Mexico Price Simulation Between Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	674.2177	1	674.2177	15.69096*	0.000362	4.130015
Within Groups	1460.93	34	42.96854			
Total	2135.148	35				

TABLE 38: ANOVA Summary for 1994 New Zealand Price Simulation

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1703.71	2	851.8548	8.891004*	0.000519	3.190721
Within Groups	4598.922	48	95.81087			
Total	6302.631	50				

TABLE 39: ANOVA Summary for 1994 New Zealand Price Simulation Between Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	396.3151	1	396.3151	3.600046	0.065821	4.113161
Within Groups	3963.1	36	110.0861			
Total	4359.415	37				

TABLE 40: ANOVA Summary for 1994 New Zealand Price Simulation Between Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1698.478	1	1698.478	11.70181*	0.002073	4.2252
Within Groups	3773.813	26	145.1466			
Total	5472.29	27				

TABLE 41: ANOVA Summary for 1994 New Zealand Price Simulation Between Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	674.2177	1	674.2177	**15.69096***	0.000362	4.130015
Within Groups	1460.93	34	42.96854			
Total	2135.148	35				

TABLE 42: ANOVA Summary for 1994 Free Trade Price Simulation

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1542.0440	2	771.022	**8.561191***	0.000661	3.190721
Within Groups	4322.8864	48	90.06014			
Total	5864.93049	50				

TABLE 43: ANOVA Summary for 1994 Free Trade Price Simulation Between Groups H1 and H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	247.4032	1	247.4032	2.421951	0.128394	4.113161
Within Groups	3677.413	36	102.1504			
Total	3924.816	37				

TABLE 44: ANOVA Summary for 1994 Free Trade Price Simulation Between Groups H1 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1088.442	1	1088.442	**6.355336***	0.017925	4.210008
Within Groups	4624.136	27	171.2643			
Total	5712.578	28				

TABLE 45: ANOVA Summary for 1994 Free Trade Price Simulation Between Groups H2 and H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	431.3041	1	431.3041	**5.924499***	0.020175	4.121347
Within Groups	2548.003	35	72.8001			
Total	2979.308	36				

APPENDIX O

ANOVA Summary for Farm Economic Profit valuing Family & Operator Labour at Zero

Herd Size Distribution of Data

TABLE 1: ANOVA Summary for 1996 US Price Simulation: Group H1

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	761.3412	1	761.3413	**10.95218***	0.0035	4.35125
Within Groups	1390.3007	20	69.51504			
Total	2151.6420	21				

TABLE 2: ANOVA Summary for 1996 Mexico Price Simulation: Group H1

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	761.3412	1	761.3413	**10.95218***	0.0035	4.35125
Within Groups	1390.3007	20	69.51504			
Total	2151.6420	21				

TABLE 3: ANOVA Summary for 1996 New Zealand Price Simulation: Group H1

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	761.3412	1	761.3413	**10.95218***	0.0035	4.35125
Within Groups	1390.3007	20	69.51504			
Total	2151.6420	21				

TABLE 4: ANOVA Summary for 1996 Free Trade Price Simulation: Group H1

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	761.3413	1	761.3413	**11.25941***	0.003148	4.35125
Within Groups	1352.364	20	67.61819			
Total	2113.705	21				

TABLE 5: ANOVA Summary for 1995 US Price Simulation: Group H1

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1545.0895	1	1545.09	**21.86928***	7.9E-05	4.2252
Within Groups	1836.9292	26	70.65113			
Total	3382.0188	27				

TABLE 6: ANOVA Summary for 1995 Mexico Price Simulation: Group H1

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1545.0895	1	1545.09	**21.86928***	7.9E-05	4.2252
Within Groups	1836.9292	26	70.65113			
Total	3382.0188	27				

TABLE 7: ANOVA Summary for 1995 New Zealand Price Simulation: Group H1

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1545.0895	1	1545.09	**21.86928***	7.9E-05	4.2252
Within Groups	1836.9292	26	70.65113			
Total	3382.0188	27				

TABLE 8: ANOVA Summary for 1995 Free Trade Price Simulation: Group H1

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1545.09	1	1545.09	**22.75525***	6.16E-05	4.2252
Within Groups	1765.409	26	67.90036			
Total	3310.499	27				

TABLE 9: ANOVA Summary for 1994 US Price Simulation: Group H1

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1478.575	1	1478.575	**6.720193***	0.014982	4.195982
Within Groups	6160.55	28	220.0197			
Total	7639.125	29				

TABLE 10: ANOVA Summary for 1994 Mexico Price Simulation: Group H1

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1478.575	1	1478.575	**6.720193***	0.014982	4.195982
Within Groups	6160.55	28	220.0197			
Total	7639.125	29				

TABLE 11: ANOVA Summary for 1994 New Zealand Price Simulation: Group H1

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1478.575	1	1478.575	6.720193*	0.014982	4.195982
Within Groups	6160.55	28	220.0197			
Total	7639.125	29				

TABLE 12: ANOVA Summary for 1994 Free Trade Price Simulation: Group H1

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1478.575	1	1478.575	7.295936*	0.011598	4.195982
Within Groups	5674.404	28	202.6573			
Total	7152.978	29				

TABLE 13: ANOVA Summary for 1996 US Price Simulation: Group H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	963.438298	1	963.4383	27.68292*	4.54E-06	4.07266
Within Groups	1461.710321	42	34.80263			
Total	2425.148619	43				

TABLE 14: ANOVA Summary for 1996 Mexico Price Simulation: Group H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	963.438298	1	963.4383	27.68292*	4.54E-06	4.07266
Within Groups	1461.710321	42	34.80263			
Total	2425.148619	43				

TABLE 15: ANOVA Summary for 1996 New Zealand Price Simulation: Group H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	963.438298	1	963.4383	27.68292*	4.54E-06	4.07266
Within Groups	1461.710321	42	34.80263			
Total	2425.148619	43				

TABLE 16: ANOVA Summary for 1996 Free Trade Price Simulation: Group H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	963.4383	1	963.4383	**27.96571***	4.16E-06	4.07266
Within Groups	1446.929	42	34.4507			
Total	2410.368	43				

TABLE 17: ANOVA Summary for 1995 US Price Simulation: Group H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1375.5377	1	1375.538	**17.20327***	0.000182	4.098169
Within Groups	3038.4008	38	79.95792			
Total	4413.9386	39				

TABLE 18: ANOVA Summary for 1995 Mexico Price Simulation: Group H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1375.5377	1	1375.538	**17.20327***	0.000182	4.098169
Within Groups	3038.4008	38	79.95792			
Total	4413.9386	39				

TABLE 19: ANOVA Summary for 1995 New Zealand Price Simulation: Group H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1375.5377	1	1375.538	**17.20327***	0.000182	4.098169
Within Groups	3038.4008	38	79.95792			
Total	4413.9386	39				

TABLE 20: ANOVA Summary for 1995 Free Trade Price Simulation: Group H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1375.538	1	1375.538	**18.16816***	0.000129	4.098169
Within Groups	2877.035	38	75.71145			
Total	4252.573	39				

TABLE 21: ANOVA Summary for 1994 US Price Simulation: Group H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1608.843	1	1608.843	44.26845*	3.69E-08	4.061704
Within Groups	1599.087	44	36.34288			
Total	32 07.93	45				

TABLE 22: ANOVA Summary for 1994 Mexico Price Simulation: Group H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1608.843	1	1608.843	44.26845*	3.69E-08	4.061704
Within Groups	1599.087	44	36.34288			
Total	32 07.93	45				

TABLE 23: ANOVA Summary for 1994 New Zealand Price Simulation: Group H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1608.843	1	1608.843	44.26845*	3.69E-08	4.061704
Within Groups	1599.087	44	36.34288			
Total	32 07.93	45				

TABLE 24: ANOVA Summary for 1994 Free Trade Price Simulation: Group H2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1608.843	1	1608.843	45.16318	2.94E-08	4.061704
Within Groups	1567.407	44	35.62289			
Total	3176.25	45				

TABLE 25: ANOVA Summary for 1996 US Price Simulation: Group H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	96.8986	1	96.89865	3.540559	0.071127	4.2252
Within Groups	711.5725	26	27.36817			
Total	808.4711	27				

TABLE 26: ANOVA Summary for 1996 Mexico Price Simulation: Group H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	96.8986	1	96.89865	3.540559	0.071127	4.2252
Within Groups	711.5725	26	27.36817			
Total	808.4711	27				

TABLE 27: ANOVA Summary for 1996 New Zealand Price Simulation: Group H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	96.8986	1	96.89865	3.540559	0.071127	4.2252
Within Groups	711.5725	26	27.36817			
Total	808.4711	27				

TABLE 28: ANOVA Summary for 1996 Free Trade Price Simulation: Group H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	96.89865	1	96.89865	3.957137	0.05729	4.2252
Within Groups	636.6635	26	24.48706			
Total	733.5621	27				

TABLE 29: ANOVA Summary for 1995 US Price Simulation: Group H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	152.3039	1	152.304	2.920622	0.099367	4.2252
Within Groups	1355.8424	26	52.14779			
Total	1508.1464	27				

TABLE 30: ANOVA Summary for 1995 Mexico Price Simulation: Group H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	152.3039	1	152.304	2.920622	0.099367	4.2252
Within Groups	1355.8424	26	52.14[illegible]			
Total	1508.1464	27				

TABLE 31: ANOVA Summary for 1995 New Zealand Price Simulation: Group H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	152.3039	1	152.304	2.920622	0.099367	4.2252
Within Groups	1355.8424	26	52.14779			
Total	1508.1464	27				

TABLE 32: ANOVA Summary for 1995 Free Trade Price Simulation: Group H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	163.0678	1	163.0678	2.554418	0.12207	4.2252
Within Groups	1659.777	26	63.83757			
Total	1822.845	27				

TABLE 33: ANOVA Summary for 1994 US Price Simulation: Group H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	136.0295	1	136.0295	3.048687	0.093593	4.259675
Within Groups	1070.857	24	44.61903			
Total	1206.886	25				

TABLE 34: ANOVA Summary for 1994 Mexico Price Simulation: Group H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	136.0295	1	136.0295	3.048687	0.093593	4.259675
Within Groups	1070.857	24	44.61903			
Total	1206.886	25				

TABLE 35: ANOVA Summary for 1994 New Zealand Price Simulation: Group H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	136.0295	1	136.0295	3.048687	0.093593	4.259675
Within Groups	1070.857	24	44.61903			
Total	1206.886	25				

TABLE 36: ANOVA Summary for 1994 Free Trade Price Simulation: Group H3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	136.0295	1	136.0295	3.021626	0.094977	4.259675
Within Groups	1080.447	24	45.01863			
Total	1216.477	25				

APPENDIX P

ANOVA Summary for Average Economic Profit at Selected International Milk Prices

Milk Yield Distribution of Data

TABLE 1: ANOVA Summary for 1996 US Price Simulation

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	560.991	2	280.4955	**6.654397***	0.002502	3.155932
Within Groups	2444.811	58	42.15191			
Total	3005.802	60				

TABLE 2: ANOVA Summary for 1996 US Price Simulation Between Groups M1 and M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	273.6445	1	273.6445	**6.176848***	0.01746	4.098169
Within Groups	1683.462	38	44.30164			
Total	1957.107	39				

TABLE 3: ANOVA Summary for 1996 US Price Simulation Between Groups M1 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	540.6231	1	540.6231	**12.64318***	0.001052	4.105459
Within Groups	1582.123	37	42.76007			
Total	2122.746	38				

TABLE 4: ANOVA Summary for 1996 US Price Simulation Between Groups M2 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	61.63496	1	61.63496	1.538181	0.222115	4.08474
Within Groups	1602.802	40	40.07004			
Total	1664.436	41				

TABLE 5: ANOVA Summary for 1996 Mexico Price Simulation

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	560.991	2	280.4955	**6.654397***	0.002502	3.155932
Within Groups	2444.811	58	42.15191			
Total	3005.802	60				

TABLE 6: ANOVA Summary for 1996 Mexico Price Simulation Between Groups M1 and M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	257.2556	1	257.2556	**5.885486***	0.019992	4.091277
Within Groups	1704.697	39	43.71018			
Total	1961.953	40				

TABLE 7: ANOVA Summary for 1996 Mexico Price Simulation Between Groups M1 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	540.6231	1	540.6231	**12.64318***	0.001052	4.105459
Within Groups	1582.123	37	42.76007			
Total	2122.746	38				

TABLE 8: ANOVA Summary for 1996 Mexico Price Simulation Between Groups M2 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	61.63496	1	61.63496	1.538181	0.222115	4.08474
Within Groups	1602.802	40	40.07004			
Total	1664.436	41				

TABLE 9: ANOVA Summary for 1996 New Zealand Price Simulation

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	560.991	2	280.4955	**6.654397***	0.002502	3.155932
Within Groups	2444.811	58	42.15191			
Total	3005.802	60				

TABLE 10: ANOVA Summary for 1996 New Zealand Price Simulation Between Groups M1 and M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	257.2556	1	257.2556	**5.885486***	0.019992	4.091277
Within Groups	1704.697	39	43.71018			
Total	1961.953	40				

TABLE 11: ANOVA Summary for 1996 New Zealand Price Simulation Between Groups M1 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	540.6231	1	540.6231	**12.64318***	0.001052	4.105459
Within Groups	1582.123	37	42.76007			
Total	2111.746	38				

TABLE 12: ANOVA Summary for 1996 New Zealand Price Simulation Between Groups M2 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	61.63496	1	61.63496	1.538181	0.222115	4.08474
Within Groups	1602.802	40	40.07004			
Total	1664.436					

TABLE 13: ANOVA Summary for 1996 Free Trade Price Simulation

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	249.8621	2	124.931	2.842014	0.66455	3.155932
Within Groups	2549.6	58	43.95863			
Total	2799.463	60				

TABLE 14: ANOVA Summary for 1995 US Price Simulation

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	561.8067	2	280.9034	**3.365012***	0.040779	3.140443
Within Groups	5342.572	64	83.47768			
Total	5904.378	66				

TABLE 15: ANOVA Summary for 1995 US Price Simulation Between Groups M1 and M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	443.7857	1	443.7857	**5.021663***	0.029504	4.03432
Within Groups	4418.712	50	88.37424			
Total	4862.498	51				

TABLE 16: ANOVA Summary for 1995 US Price Simulation Between Groups M1 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	370.9667	1	370.9667	**4.371373***	0.043473	4.105459
Within Groups	3139.921	37	84.86274			
Total	3510.888	38				

TABLE 17: ANOVA Summary for 1995 US Price Simulation Between Groups M2 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2.244076	1	2.244076	0.029428	0.864638	4.078544
Within Groups	3126.51	41	76.25633			
Total	3128.754	42				

TABLE 18: ANOVA Summary for 1995 Mexico Price Simulation

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	561.8067	2	280.9034	**3.365012***	0.040779	3.140443
Within Groups	5342.572	64	83.47768			
Total	5904.378	66				

TABLE 19: ANOVA Summary for 1995 Mexico Price Simulation Between Groups M1 and M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	443.7857	1	443.7857	**5.021663***	0.029504	4.03432
Within Groups	4418.712	50	88.37424			
Total	4862.498	51				

TABLE 20: ANOVA Summary for 1995 Mexico Price Simulation Between Groups M1 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	370.9667	1	370.9667	**4.371373***	0.043473	4.105459
Within Groups	3139.921	37	84.86274			
Total	3510.888	38				

TABLE 21: ANOVA Summary for 1995 Mexico Price Simulation Between Groups M2 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2.244076	1	2.244076	0.029428	0.864638	4.078544
Within Groups	3126.51	41	76.25633			
Total	3128.754	42				

TABLE 22: ANOVA Summary for 1995 New Zealand Price Simulation

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	561.8067	2	280.9034	**3.365012***	0.040779	3.140443
Within Groups	5342.572	64	83.47768			
Total	5904.378	66				

TABLE 23: ANOVA Summary for 1995 New Zealand Price Simulation Between Groups M1 and M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	443.7857	1	443.7857	**5.021663***	0.029504	4.03432
Within Groups	4418.712	50	88.37424			
Total	4862.498	51				

TABLE 24: ANOVA Summary for 1995 New Zealand Price Simulation Between Groups M1 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	370.9667	1	370.9667	**4.371373***	0.043473	4.105459
Within Groups	3139.921	37	84.86274			
Total	3510.888	38				

TABLE 25: ANOVA Summary for 1995 New Zealand Price Simulation Between Groups M2 and M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2.244076	1	2.244076	0.029428	0.864638	4.078544
Within Groups	3126.51	41	76.25633			
Total	3128.754	42				

TABLE 26: ANOVA Summary for 1995 Free Trade Price Simulation

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	417.4292	2	208.7146	2.446359	0.09467	3.140443
Within Groups	5460.25	64	85.3164			
Total	5877.679	66				

TABLE 27: ANOVA Summary for 1994 US Price Simulation

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	496.5309	2	248.2655	2.626191	0.079373	3.125763
Within Groups	6711.94	71	94.53436			
Total	7208.471	73				

TABLE 28: ANOVA Summary for 1994 Mexico Price Simulation

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	496.5309	2	248.2655	2.626193	0.079373	3.125763
Within Groups	6711.94	71	94.53436			
Total	7208.471	73				

TABLE 29: ANOVA Summary for 1994 New Zealand Price Simulation

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	496.5309	2	248.2655	2.626193	0.079373	3.125763
Within Groups	6711.94	71	94.53436			
Total	7208.471	73				

TABLE 30: ANOVA Summary for 1994 Free Trade Price Simulation

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	275.3412	2	137.6706	1.520961	0.225535	3.125763
Within Groups	6426.6	71	90.5155			
Total	6701.942	73				

APPENDIX Q

ANOVA Summary for Farm Economic Profit valuing Family & Operator Labour at Zero

Milk Yield Distribution of Data

TABLE 1: ANOVA Summary for 1996 US Price Simulation: Group M1

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1005.324	1	1005.324	**20.45413***	6.4E-05	4.113161
Within Groups	1769.407	36	49.15019			
Total	2774.731	37				

TABLE 2: ANOVA Summary for 1996 Mexico Price Simulation: Group M1

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1005.324	1	1005.324	**20.45413***	6.4E-05	4.113161
Within Groups	1769.407	36	49.15019			
Total	2774.731	37				

TABLE 3: ANOVA Summary for 1996 New Zealand Price Simulation: Group M1

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1005.324	1	1005.324	**20.45413***	6.4E-05	4.113161
Within Groups	1769.407	36	49.15019			
Total	2774.731	37				

TABLE 4: ANOVA Summary for 1996 Free Trade Price Simulation

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1005.324	1	1005.324	**19.3162***	9.38E-05	4.113161
Within Groups	1873.644	36	52.04566			
Total	2878.968	37				

TABLE 5: ANOVA Summary for 1995 US Price Simulation: Group M1

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1857.084	1	1857.084	**24.31414***	1.11E-05	4.051742
Within Groups	3513.424	46	76.37878			
Total	5370.508	47				

TABLE 6: ANOVA Summary for 1995 Mexico Price Simulation: Group M1

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1857.084	1	1857.084	**24.31414***	1.11E-05	4.051742
Within Groups	3513.424	46	76.37878			
Total	5370.508	47				

TABLE 7: ANOVA Summary for 1995 New Zealand Price Simulation: Group M1

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1857.084	1	1857.084	**24.31414***	1.11E-05	4.051742
Within Groups	3513.424	46	76.37878			
Total	5370.508	47				

TABLE 8: ANOVA Summary for 1995 Free Trade Price Simulation: Group M1

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1857.084	1	1857.084	22.81793	1.85E-05	4.051742
Within Groups	3743.806	46	81.38708			
Total	5600.89	47				

TABLE 9: ANOVA Summary for 1994 US Price Simulation: Group M1

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2007.066	1	2007.066	**17.4504***	9.11E-05	3.99092
Within Groups	7360.99	64	115.0155			
Total	9368.055	65				

TABLE 10: ANOVA Summary for 1994 Mexico Price Simulation: Group M1

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2007.066	1	2007.066	**17.4504***	9.11E-05	3.99092
Within Groups	7360.99	64	115.0155			
Total	9368.055	65				

TABLE 11: ANOVA Summary for 1994 New Zealand Price Simulation: Group M1

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2007.066	1	2007.066	**17.4504***	9.11E-05	3.99092
Within Groups	7360.99	64	115.0155			
Total	9368.055	65				

TABLE 12: ANOVA Summary for 1994 Free Trade Price Simulation: Group M1

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2007.066	1	2007.066	**18.58814***	5.72E-05	3.99092
Within Groups	6910.439	64	107.9756			
Total	8917.505	65				

TABLE 13: ANOVA Summary for 1996 US Price Simulation: Group M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	632.5888	1	632.5888	**19.12663***	7.9E-05	4.07266
Within Groups	1389.096	42	33.07372			
Total	2021.685	43				

TABLE 14: ANOVA Summary for 1996 Mexico Price Simulation: Group M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	632.5888	1	632.5888	**19.12663***	7.9E-05	4.07266
Within Groups	1389.096	42	33.07372			
Total	2021.685	43				

TABLE 15: ANOVA Summary for 1996 New Zealand Price Simulation: Group M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	632.5888	1	632.5888	**19.12663***	7.9E-05	4.07266
Within Groups	1389.096	42	33.07372			
Total	2021.685	43				

TABLE 16: ANOVA Summary for 1996 Free Trade Price Simulation: Group M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	632.5888	1	632.5888	**19.24796***	7.57E-05	4.07266
Within Groups	1380.34	42	32.86523			
Total	2012.928	43				

TABLE 17: ANOVA Summary for 1995 US Price Simulation: Group M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1345.543	1	1345.543	**18.55501***	7.02E-05	4.01954
Within Groups	3915.885	54				
Total	5261.428	55				

TABLE 18: ANOVA Summary for 1995 Mexico Price Simulation: Group M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1345.543	1	1345.543	**18.55501***	7.02E-05	4.01954
Within Groups	3915.885	54				
Total	5261.428	55				

TABLE 19: ANOVA Summary for 1995 New Zealand Price Simulation: Group M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1345.543	1	1345.543	**18.55501***	7.02E-05	4.01954
Within Groups	3915.885	54				
Total	5261.428	55				

TABLE 20: ANOVA Summary for 1995 Free Trade Price Simulation: Group M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1345.543	1	1345.543	**18.6971***	6.64E-05	4.01954
Within Groups	3886.127	54	71.96532			
Total	5231.67	55				

TABLE 21: ANOVA Summary for 1994 US Price Simulation: Group M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1358.326	1	1358.326	**43.11293***	9.56E-08	4.098169
Within Groups	1197.237	38	31.50623			
Total	2555.562	39				

TABLE 22: ANOVA Summary for 1994 Mexico Price Simulation: Group M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1358.326	1	1358.326	**43.11293***	9.56E-08	4.098169
Within Groups	1197.237	38	31.50623			
Total	2555.562	39				

TABLE 23: ANOVA Summary for 1994 New Zealand Price Simulation: Group M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1358.326	1	1358.326	**43.11293***	9.56E-08	4.098169
Within Groups	1197.237	38	31.50623			
Total	2555.562	39				

TABLE 24: ANOVA Summary for 1994 Free Trade Price Simulation: Group M2

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	1358.326	1	1358.326	**41.45164***	1.43E-07	4.098169
Within Groups	1245.219	38	32.76893			
Total	2603.545	39				

TABLE 25: ANOVA Summary for 1996 US Price Simulation: Group M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	610.3638	1	610.3638	**16.13573***	0.000269	4.098169
Within Groups	1437.42	38	37.82685			
Total	2047.784	39				

TABLE 26: ANOVA Summary for 1996 Mexico Price Simulation: Group M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	610.3638	1	610.3638	**16.13573***	0.000269	4.098169
Within Groups	1437.42	38	37.82685			
Total	2047.784	39				

TABLE 27: ANOVA Summary for 1996 New Zealand Price Simulation: Group M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	610.3638	1	610.3638	**16.13573***	0.000269	4.098169
Within Groups	1437.42	38	37.82685			
Total	2047.784	39				

TABLE 28: ANOVA Summary for 1996 Free Trade Price Simulation: Group M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	610.3638	1	610.3638	**15.50345***	0.00034	4.098169
Within Groups	1496.042	38	39.36953			
Total	2106.406	39				

TABLE 29: ANOVA Summary for 1995 US Price Simulation: Group M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	687.1543	1	687.1543	**10.46216***	0.00312	4.195982
Within Groups	1839.039	28	65.67997			
Total	2526.193	29				

TABLE 30: ANOVA Summary for 1995 Mexico Price Simulation: Group M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	687.1543	1	687.1543	**10.46216***	0.00312	4.195982
Within Groups	1839.039	28	65.67997			
Total	2526.193	29				

TABLE 31: ANOVA Summary for 1995 New Zealand Price Simulation: Group M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	687.1543	1	687.1543	**10.46216***	0.00312	4.195982
Within Groups	1839.039	28	65.67997			
Total	2526.193	29				

TABLE 32: ANOVA Summary for 1995 Free Trade Price Simulation

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	687.1543	1	687.1543	**10.71732***	0.002824	4.195982
Within Groups	1795.254	28	64.11622			
Total	2482.408	29				

TABLE 33: ANOVA Summary for 1994 US Price Simulation: Group M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	884.9822	1	884.9822	**10.80297***	0.002115	4.08474
Within Groups	3276.811	40	81.92027			
Total	4161.793	41				

TABLE 34: ANOVA Summary for 1994 Mexico Price Simulation: Group M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	884.9822	1	884.9822	**10.80297***	0.002115	4.08474
Within Groups	3276.811	40	81.92027			
Total	4161.793	41				

TABLE 35: ANOVA Summary for 1994 New Zealand Price Simulation: Group M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	884.9822	1	884.9822	**10.80297***	0.002115	4.08474
Within Groups	3276.811	40	81.92027			
Total	4161.793	41				

TABLE 36: ANOVA Summary for 1994 Free Trade Price Simulation: Group M3

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	884.9822	1	884.9822	**11.41885***	0.001632	4.08474
Within Groups	3100.076	40	77.5019			
Total	3985.058	41				

APPENDIX R

ANOVA Summary for Miscellaneous Items

TABLE 1: ANOVA Summary for Change in Hours of Family Labour of Group H3: 1994 - 1996

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	10810837.48	1	10810837.48	**13.33381***	0.001205	4.241699
Within Groups	20269601.25	25	810784.0499			
Total	31080438.73	26				

TABLE 2: ANOVA Summary for Change in Average Total Feed Cost: 1996 - 1995

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	301.6828	1	301.6828	**32.24371***	9.02E-08	3.916938
Within Groups	1169.542	125	9.356332			
Total	1471.224	126				

TABLE 3: ANOVA Summary for Change in Average Total Feed Cost: 1996 - 1994

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	515.3515	1	515.3515	**46.46912***	2.95E-10	3.912334
Within Groups	1474.996	133	11.09019			
Total	1990.347	134				

TABLE 4: ANOVA Summary for Change in Average Hired Labour Cost: 1996 - 1995

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	2.131986	1	2.131986	0.472417	0.49314	3.916327
Within Groups	568.6291	126	4.51293			
Total	570.7611	127				

TABLE 5: ANOVA Summary for Change in Average Hired Labour Cost: 1996 - 1994

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.137999	1	0.137999	0.027645	0.8682	3.912334
Within Groups	663.9232	133	4.991904			
Total	664.0612	134				

TABLE 6: ANOVA Summary for Change in Average Operator Labour Cost: 1996 - 1995

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.078189	1	0.078189	0.007204	0.932496	3.916327
Within Groups	1367.608	126	10.85403			
Total	1367.686	127				

TABLE 7: ANOVA Summary for Change in Average Operator Labour Cost: 1996 - 1994

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	8.401641	1	8.401641	0.958199	0.329418	3.912334
Within Groups	1166.165	133	8.76816			
Total	1174.567	134				

TABLE 8: ANOVA Summary for Change in Average Labour Productivity of Group H1: 1996 - 1994

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	312.1996	1	312.1996	**9.781824***	0.004574	4.259675
Within Groups	765.9911	24	31.9163			
Total	1078.191	25				

TABLE 9: ANOVA Summary for Change in Average Labour Productivity of Group H2: 1996 - 1994

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	603.9256	1	603.9256	**25.68357***	8.1E-06	4.067047
Within Groups	1011.106	43	23.51409			
Total	1615.031	44				

TABLE 10: ANOVA Summary for Change in Average Labour Productivity of Group H3: 1996 - 1994

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	608.3468	1	608.3468	**4.471374***	0.044611	4.241699
Within Groups	3401.341	25	136.0536			
Total	4009.688	26				

TABLE 11: ANOVA Summary for Change in Labour Cost Control Ratio of Group H1: 1996 - 1994

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.084155	1	0.084155	7.115037*	0.013475	4.259675
Within Groups	0.283866	25	0.011828			
Total	0.368021	26				

TABLE 12: ANOVA Summary for Change in Labour Cost Control Ratio of Group H2: 1996 - 1994

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.033721	1	0.033721	9.189991*	0.004111	4.067047
Within Groups	0.15778	43	0.003669			
Total	0.1915	44				

TABLE 13: ANOVA Summary for Change in Labour Cost Control Ratio of Group H2: 1996 - 1994

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.033721	1	0.084155	7.115037*	0.013475	4.259675
Within Groups	0.283866	25	0.011828			
Total	0.368021	26				

TABLE 14: ANOVA Summary for Change in Labour Cost Control Ratio of Group H3: 1996 - 1994

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	0.007673	1	0.007673	3.44276	0.075178	4.241699
Within Groups	0.055648	25	0.002226			
Total	0.063321	26				